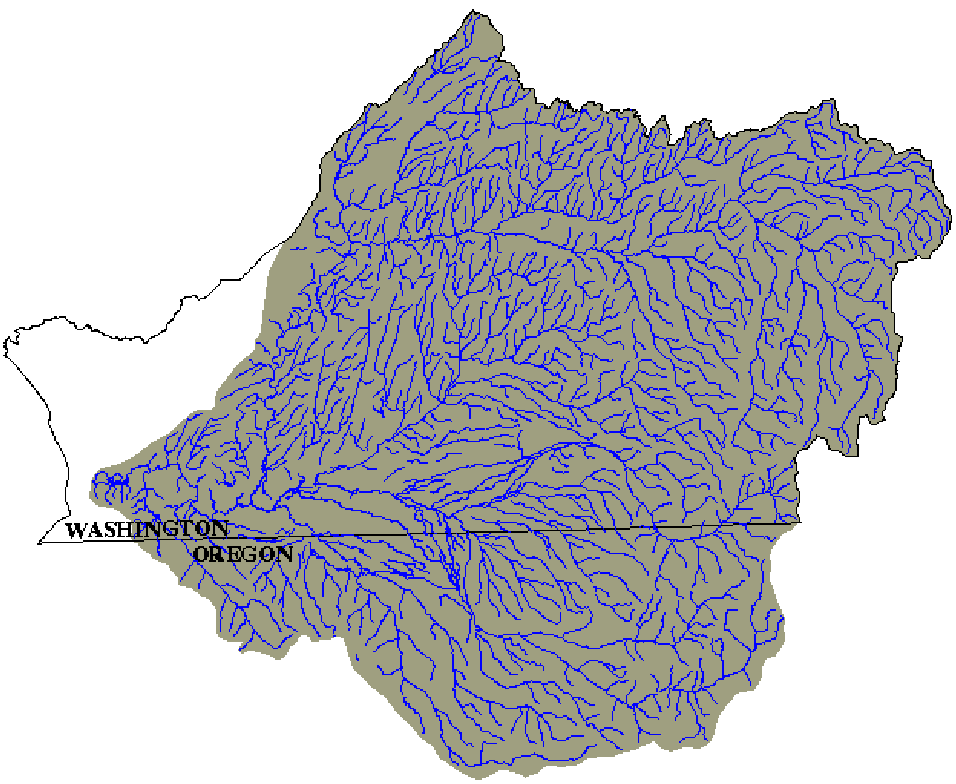
Washington State Conservation Commission

SALMONID HABITAT LIMITING FACTORS WATER RESOURCE INVENTORY AREA 32 WALLA WALLA WATERSHED



FINAL REPORT
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ABBREVIATIONS AND ACRONYMS

BPA: Bonneville Power Administration
BOR: Bureau of Reclamation
CTUIR: Confederated Tribes of the Umatilla Indian Reservation
CCCD: Columbia County Conservation District
CCRP: Cooperative Compliance Review Program, WDFW
CREP: Conservation Reserve Enhancement Program
CRP: Conservation Reserve Program
DEQ: Oregon Department of Environmental Quality
DO: Dissolved Oxygen
DOE: Washington Department of Ecology
ESA: Endangered Species Act
FLIR: Forward Looking Infrared Reconnaissance (infrared photography)
ICBEMP: Interior Columbia Basin Ecosystem Management Project
IFIM: Instream Flow Incremental Methodology
LB: Left Bank of stream (looking downstream)
LWD: Large Woody Debris
NMFS: National Marine Fisheries Service
NWPPC: Northwest Power Planning Council
ODFW: Oregon Department of Fish and Wildlife
OWRD: Oregon Water Resources Department
POD: Point of Diversion
RAPFAHRS: Rapid Assessment Procedure For Aquatic Habitat, Riparian, & Streambanks
RB: Right Bank of stream (looking downstream)
RM: River Mile
SRFB: Washington State Salmon Recovery Funding Board
TSS: Total Suspended Solids
TWG: Walla Walla Watershed Technical Workgroup
USACE: United States Army Corps of Engineers
USFS: United States Forest Service
USFWS: United States Fish and Wildlife Service
WCC: Washington State Conservation Commission
WDFW: Washington Department of Fish and Wildlife
WRIA: Water Resource Inventory Area
WWCD: Walla Walla Conservation District

EXECUTIVE SUMMARY

The Walla Walla Watershed encompasses portions of Southeast Washington and Northeast Oregon. The Washington portion, which represents about 73% of the basin, is identified as Water Resource Inventory Area (WRIA) 32. The basin historically supported large numbers of salmonids including spring chinook, summer steelhead, and bull trout (Confederated Tribes of the Umatilla Indian Reservation *et al.* 1990; Mendel *et al.* 1999). Spring chinook have been extinct since 1950 (Mendel *et al.* 1999. Summer steelhead and bull trout are listed as endangered under the Endangered Species Act (ESA) (U.S.Fish and Wildlife Service 1998, National Marine Fisheries Service 1999).

Landuse impacts associated with surface water withdrawals, dryland agriculture, and residential development have had profound negative impacts on salmonid habitat on private lands in both the Washington and Oregon portions of the basin. Many of these stream reaches exhibit low or non-existent summer stream flows and water temperatures far above the tolerance level of salmonids. These conditions are a combination of naturally arid summer climatic conditions, surface water withdrawals, removal of riparian vegetation, and disruption of surface water-ground water exchanges (hydraulic continuity) through bank armoring, channel straightening, and diking of floodplains. Hundreds of inadequately screened surface water diversions are present in salmonid bearing streams. Many stream reaches adjacent to or downstream from private lands carry extremely high fine sediment loads derived from erosion of agricultural fields. This has led to embedded and/or buried streambed substrate, significantly reducing the area available for salmonid spawning habitat. The majority of these reaches also lack instream habitat complexity associated with abundant amounts of large woody debris (LWD), pools, and off-channel habitat.

Habitat conditions on public lands managed by the United States Forest Service (USFS) standout in stark contrast to those found on private lands downstream. Headwater reaches of streams throughout the Blue Mountains in Washington and Oregon provide the last remaining area of refuge for spawning and rearing summer steelhead and bull trout. In some cases (such as LWD and pool quantities), conditions on these stream reaches are not ideal, but they are far more favorable to salmonids than those found downstream on private lands.

This report deals with habitat conditions only. It does not deal with harvest, hydropower, or hatchery issues. The report is a summary of existing knowledge from published sources and interviews of people with expertise in the Walla Walla Watershed. It is intended to provide guidance for implementation of salmonid habitat restoration projects. It is not a recovery plan for summer steelhead or bull trout, although it could be a component of such a plan. Habitat conditions are described, then assessed based on standards developed from published sources and consultations with local natural resource agency personnel, finally recommendations are made to improve habitat conditions.

WALLA WALLA WATERSHED BASIN-WIDE RECOMMENDATIONS

1. Conduct a comprehensive inventory of surface water diversions (legal and illegal) in Washington and Oregon.
2. Screen all surface water diversions in Washington and Oregon according to state and federal juvenile fish screening criteria.
3. Replace push-up dams with more permanent structures that reduce streambed disturbance and improve fish passage.
4. Increase summer stream flows in the Lower Touchet and Lower Walla Walla subbasins as well as downstream from Nursery Bridge in Oregon. Summer flows on fish bearing tributary streams should also be restored.
5. Where possible, conserve water by converting irrigated agriculture to dryland farming, reducing lawn watering, car washing, etc.
6. Utilize no-till farming methods on as many acres of dry farmed cropland as possible.
7. Replant native riparian vegetation along streams beginning on the upper reaches of spawning and rearing areas, then progressing downstream to lower priority migration areas.
8. Reduce summer water temperatures to comply with state standards for salmonid habitat usage.
9. Improve instream habitat on the upper reaches of spawning and rearing areas by providing large woody debris, consolidating braided channels, stabilizing eroding banks with bioengineering, and creating pools.
10. Restore floodplain connectivity and natural channel migration by removing or setting back dikes and levees and removing bank armoring.
11. Continue to identify fish passage problems and correct barriers that restrict access to useable habitat.
12. Increase water quality monitoring to ensure that streams comply with state water quality standards and correct violations where identified.
13. Determine the appropriate management strategy of Mill Creek below Bennington Lake Dam and Yellowhawk and Garrison Creeks, including investigating the feasibility of screening-off Mill Creek at Gose Road and at the Yellowhawk Division. Yellowhawk Creek would then serve as the migration corridor from the Walla Walla River to the Upper Mill Creek Subbasin.
14. In emergency situations, restrict unpermitted flood repair work to a short timeframe during which an eminent threat of damage to life or property exists, thereby minimizing destruction of salmonid habitat.
15. Enforce landuse regulations including the Growth Management Act, Shoreline Management Act, and Critical Area ordinances.
16. Fence livestock out of streams.
17. Increase protection of critical salmonid habitat areas. See Habitat to Protect.

Table 1. Walla Walla Watershed Landmarks.

Landmark	River Mile
Walla Walla River	
Historic mouth of the Walla Walla River	0.0
Current mouth of the Walla Walla River	3.2
Touchet River (RB)	22.6
Pine Creek (LB)	24.1
Mud Creek (LB)	27.9
Dry Creek (RB)	29.4
McDonald Road Bridge	31.6
West Little Walla Walla River (LB)	33.4
Mill Creek (RB)	33.5
Burlingame Diversion Dam	37.4
East Little Walla Walla River (LB)	38.1
Yellowhawk Creek (RB)	38.9
Stateline	41.9
Nursery Bridge Diversion Dam	46.0
Little Walla Walla Diversion Dam	47.0
Couse Creek (LB)	48.6
Confluence of North and South Forks	52.0
South Fork Walla Walla River	
Confluence of the North and South Forks	0.0
Flume Canyon Creek	4.5
Harris County Park	7.5
Start of BLM Ownership	8.0
Elbow Creek	9.8
End of BLM Ownership	11.5
Forest Boundary	12.8
Burnt Cabin Creek	14.1
Table Creek	15.5
Skiphorton Creek	17.0
Reser Creek	19.9
Deduct Springs (source of the South Fork Walla Walla River)	27.1

Table 1. Continued.

Landmark	River Mile
North Fork Walla Walla River	
Confluence of North and South Forks	0.0
End of County Road	3.5
Forest Boundary	11.0
Source of the North Fork Walla Walla River	18.0
Touchet River	
Mouth of the Touchet River	0.0
Prescott, WA	34.3
Coppei Creek (LB)	43.0
Waitsburg, WA	44.0
Dayton, WA	57.0
Patit Creek (RB)	57.2
Confluence of North and South Forks	55.0
North Fork Touchet River	
Confluence of North and South Forks	0.0
Wolf Fork (LB)	3.5
Jim Creek (RB)	7.3
Lewis Creek	10.6
End of Paved County Road	10.9
Forest Boundary (RB)	11.9
Spangler Creek (RB)	13.8
"Bluewood Creek"	18.6
Source of the North Fork Touchet River	20.0
South Fork Touchet River	
Confluence of North and South Forks	0.0
Rainwater Wildlife Area Boundary	10.9
Griffin Fork (RB)	14.4
Burnt Fork (RB)	15.7
Forest Boundary	19.6
Source of the South Fork Touchet River (Green Fork)	20.2

Table 1. Continued.

Landmark	River Mile
Mill Creek	
Mouth of Mill Creek	0.0
Lower End of Mill Creek Project (Gose Road)	4.8
Yellowhawk/Garrison Diversion	10.5
Bennington Lake Diversion Dam	11.5
Blue Creek (RB)	16.9
Old City Water Intake Dam	21.2
Stateline	21.6
Henry Canyon Creek (LB)	23.2
Tiger Creek (LB)	24.6
Forest Boundary	24.7
New City Water Intake Dam	25.2
Low Creek	25.7
Broken Creek	26.0
Stateline	26.4
Paradise Creek	26.7
North Fork Mill Creek	28.3
Deadman Creek	30.6
Source of Mill Creek	33.0

Note: Source Northrop (1998) and Washington Department of Fish and Wildlife Stream Catalog.

INTRODUCTION

How to Use This Document

This report is made available in a digital format known as portable document format (pdf). This allows anyone with a computer (regardless of platform) and free Adobe Acrobat Reader 4.0 software to read and print the document. If you are reading the report on your computer you can take advantage of features commonly found on web pages. The Acrobat software allows you to search the document for your topic of interest. You will also notice blue underlined text throughout the document. These pieces of text are hyperlinks that will take you directly to tables, figures, and maps in the report. You may also view maps and the report simultaneously by manually opening a map from the CD-ROM while you are reading the narrative. Adobe Acrobat Reader 4.0 is available at: http://www.adobe.com/products/acrobat/readstep.html.

Salmonid Habitat Limiting Factors Background

The successful recovery of naturally spawning salmon populations depends upon directing actions simultaneously at harvest, hatcheries, habitat and hydropower, the 4H's. The 1998 state legislative session produced a number of bills aimed at salmon recovery. Engrossed Substitute House Bill (ESHB) 2496 is a key piece of the 1998 Legislature's salmon recovery effort, with the focus directed at salmon habitat issues.

Engrossed Substitute House Bill (ESHB) 2496 in part:

- Directs the Conservation Commission in consultation with local government and the tribes to invite private, federal, state, tribal and local government personnel with appropriate expertise to act as a technical advisory group;
- Directs the technical advisory group (TAG) to identify limiting factors for salmonids to respond to the limiting factors relating to habitat pursuant to section 8 subsection 2 of this act;
- Defines limiting factors as "conditions that limit the ability of habitat to fully sustain populations of salmon;"
- Defines salmon as all members of the family salmonidae, which are capable of self-sustaining, natural production.

The overall goal of the Conservation Commission's limiting factors project is to identify habitat factors limiting production of salmon in the state. It is important to note that the responsibilities given to the Conservation Commission in ESHB 2496 do not constitute a full limiting factors analysis. The hatchery, hydropower, and harvest limiting factors are being dealt with in other forums.

The Relative Role of Habitat in Healthy Populations of Natural Spawning Salmon (Chapter Author — Carol Smith, PhD, note: edited by the report Author)

During the last 10,000 years, Washington State Anadromous salmonid populations have evolved in their specific habitats (Miller 1965). Water chemistry, flow, and the physical stream components unique to each stream have helped shape the characteristics of every salmon population. These unique physical attributes have resulted in a wide variety of distinct salmon stocks for each species throughout the state. Within a given species, stocks are population units that do not extensively interbreed because returning adults rely on a stream's unique chemical and physical characteristics to guide them to their natal grounds to spawn. This maintains the separation of stocks during reproduction, preserving the distinctiveness of each stock.

Throughout the salmon's life cycle, the dependence between the stream and a stock continues. Adults spawn in areas near their own origin because survival favors those that do. The timing of juveniles leaving the river and entering the estuary is tied to high natural river flows. It has been theorized that the faster speed during outmigration reduces predation on the young salmon and perhaps is coincident to favorable feeding conditions in the estuary (Wetherall 1971). These are a few examples that illustrate how a salmon stock and its environment are intertwined throughout the entire life cycle.

Salmon habitat includes the physical, chemical and biological components of the environment that support salmon. Within freshwater and estuarine environments, these components include water quality, water quantity or flows, stream and river physical features, riparian zones, upland terrestrial conditions, and ecosystem interactions as they pertain to habitat. However, these components closely intertwine. Low stream flows can alter water quality by increasing temperatures and decreasing the amount of available dissolved oxygen, while concentrating toxic substances. Water quality can impact stream conditions through heavy sediment loads, which decrease spawning success or through water pollution that reduces salmonid survival. The riparian zone interacts with the stream environment, providing nutrients and a food web base and woody debris for habitat and flow control. It also filters runoff and shades the stream to aid in water temperature control.

Salmon habitat includes clean, cool, well-oxygenated water flowing at a normal (natural) rate for all stages of freshwater life. In addition, salmon survival depends upon specific habitat needs for egg incubation, juvenile rearing, migration of juveniles to saltwater, estuary rearing, ocean rearing, adult migration to spawning areas, and spawning. These specific needs can vary by species and even by stock.

When adults return to spawn, they not only need adequate flows and water quality, but also unimpeded passage to their spawning grounds. They need deep pools with vegetative cover and instream structures such as root wads for resting and shelter from predators. Successful spawning and incubation depend on sufficient clean gravel of the right size for that particular population, in addition to the constant need of adequate flows and water quality, all in unison at the necessary location. Also, delayed upstream migration can be critical. After entering freshwater, most salmon have a limited time to migrate and spawn, in some cases, as little as 2-3 weeks. Delays can result in pre-spawning mortality, or spawning in a sub-optimum location.

After spawning, the eggs need stable gravel that is not choked with sediment. River channel stability is vital at this life history stage. Floods have their greatest impact to salmon populations during incubation, and flood impacts are worsened by human activities. In a natural river system, the upland areas are forested, and the trees and their roots store precipitation, which slows the rate of storm water runoff into the stream. The natural, healthy river is sinuous and contains large pieces of wood contributed by an intact, mature riparian zone. Both slow the speed of water downstream. Natural systems have floodplains that are connected directly to the river at many points, allowing wetlands to store flood water and later discharge this storage back to the river during low flows. In a healthy river, erosion or sediment input is great enough to provide new gravel for spawning and incubation, but does not overwhelm the system, raising the riverbed and increasing channel instability. A stable incubation environment is essential for salmon, but is a complex function of nearly all habitat components contained within that river ecosystem.

Once the young fry emerge from the gravel nests, certain species such as chum, pink, and fall chinook salmon quickly migrate downstream to the estuary. Other species such as coho, steelhead, bull trout, and spring chinook will search for suitable rearing habitat within the side sloughs and channels, tributaries, and spring-fed “seep” areas, as well as the outer edges of the stream. These quiet-water side margin and off-channel slough areas are vital for early juvenile habitat. Woody debris and overhead cover provide protection from predators and habitat for forage species. Most juvenile salmonids use this type of habitat in the spring.

As growth continues, the juvenile salmon (parr) move away from the quiet shallow areas to deeper, faster areas of the stream. These include coho, steelhead, bull trout, and spring chinook. For some of these species, this movement is coincident with the summer low flows. Low flows constrain salmon production for stocks that rear within the stream. In non-glacial streams, summer flows are maintained by precipitation, connectivity to wetland discharges, and groundwater inputs. Reductions in these inputs will reduce habitat; hence the number of salmon dependent on adequate summer flows.

In the fall, juvenile salmon that remain in freshwater begin to move out of the mainstems, and off-channel habitat again becomes important. During the winter, coho, steelhead, bull trout, and remaining chinook parr require habitat to sustain their growth and protect them from predators and winter flows. Wetlands, stream habitat protected from the effects of high flows, and pools with overhead cover are important habitat components during this time.

Except for bull trout and resident steelhead (rainbow/redband trout), juvenile parr convert to smolts as they migrate downstream toward the estuary. Again, flows are critical, and food and shelter are necessary. The natural flow regime in each river is unique, and has shaped the population’s characteristics through adaptation over the last 10,000 years.

Because of the close inter-relationship between a salmon stock and its stream, survival of the stock depends heavily on natural flow patterns.

The estuary provides an ideal area for rapid growth, and some salmon species are heavily dependent on estuaries, particularly chinook, chum, and to a lesser extent, pink salmon. Estuaries contain new food sources to support the rapid growth of salmon smolts, but adequate natural habitat must exist to support the detritus-based food web, such as eelgrass beds, mudflats, and salt marshes. Also, the processes that contribute nutrients and woody debris to these environments must be maintained to provide cover from predators and to sustain the food web. Common disruptions to these habitats include dikes, bulkheads, dredging and filling activities, pollution, and alteration of downstream components such as a lack of woody debris and sediment transport.

All salmonid species need adequate flow and water quality, spawning riffles and pools, a functional riparian zone, and upland conditions that favor stability, but some of these specific needs vary by species, such as preferred spawning areas and gravel. Although some overlap occurs, different salmon species within a river are often staggered in their use of a particular type of habitat. Some are staggered in time, and others are separated by distance.

Chinook Salmon Life History

Chinook salmon *(Oncorhynchus tshawytscha)* have three major run types in Washington State. Juvenile spring chinook are generally in their natal rivers throughout the calendar year. Adults begin river entry in May or early June. Spring chinook spawn from July through September, typically in headwater areas where higher gradient habitat exists. Incubation continues throughout the autumn and winter, and generally requires more time for the eggs to develop into fry because of the colder temperatures in the headwater areas. Fry begin to leave the gravel nests in February through early March. The juveniles of spring chinook salmon stocks in the Columbia Basin exhibit some distinct life history characteristics. Generally, these stocks remain in the basin for a full year. However, some stocks migrate downstream from their natal tributaries in the fall and early winter into larger rivers, including the Columbia, where they are believed to over-winter prior to outmigration the next spring as yearling smolts.

All Washington summer and fall chinook stocks have juveniles that incubate in the gravel until January through early March, and migrate downstream to estuaries over a broad time period (January through August). Adult summer chinook begin river entry as early as June in the Columbia. They generally spawn in September and/or October. Fall chinook stocks enter freshwater in late summer or fall and range in spawn timing from late September through December. A few of these stocks have a component of juveniles that remain in freshwater for a full year after emerging from the gravel nests.

While some emerging chinook salmon fry outmigrate quickly, most inhabit the shallow side margins and side sloughs for up to two months. Then, some gradually move into the faster water areas of the stream to rear, while others outmigrate to the estuary. Most summer and fall chinook outmigrate within their first year of life, but a few stocks (Snohomish summer chinook, Snohomish fall chinook, and upper Columbia summer chinook) have juveniles that remain in the river for an additional year, similar to many spring chinook (Marshall *et al.* 1995). However, those in the upper Columbia, have scale patterns that suggest that they rear in a reservoir-like environment (mainstem Columbia upstream from a dam) rather than in their natal streams and it is unknown whether this is a result of dam influence or whether it is a natural pattern.

As they grow, juvenile salmonids move into faster water and disperse into tributaries and areas which adults cannot access (Neave 1949). Pool habitat is important not only for returning adults, but for all stages of juvenile development. Quality pool habitat includes deep pools with overhanging riparian cover, large woody debris, and large cobble/boulder substrate.

<u>Steelhead/Rainbow Trout Life History</u>

Steelhead *(Oncorhynchus mykiss)* have the most complex life history patterns of any Pacific salmonid species (Shapovalov and A. C. Taft 1954). In Washington, there are two major run types, winter and summer steelhead. Winter steelhead adults begin river entry in a mature reproductive state in December and generally spawn from February through May. Summer steelhead adults enter the river from about May through October with spawning from about February through April. They enter the river in an immature state and require several months to mature (Burgner *et al.* 1992). Summer steelhead usually spawn farther upstream than winter stocks (Withler 1966) and dominate inland areas such as the Columbia Basin. However, the coastal streams support more winter steelhead populations.

Juvenile steelhead can either migrate to sea or remain in freshwater as rainbow or redband trout. In Washington, those that are anadromous usually spend 1-3 years in freshwater, with the greatest proportion spending two years (Busby *et al.* 2000). Because of this, steelhead rely heavily on freshwater habitat and are present in streams all year long.

<u>Bull Trout Life History</u>

Bull trout *(Salvelinus confluentus)* are also very dependent on the freshwater environment, where they reproduce only in clean, cold, relatively pristine streams. Bull trout exhibit a complex life history that includes four possible strategies. Resident fish stay in the natal stream their entire life. Fluvial fish migrate (as juveniles) from the natal stream to a larger river, adfluvial juveniles migrate upstream or downstream to a lake or reservoir, and anadromous juveniles migrate to saltwater and return as adults to spawn in freshwater. These last three strategies are utilized to take advantage of increased food supplies, similar to anadromous salmonid maturation in the ocean. Adult bull trout return to the natal stream to spawn (Goetz 1989). Bull trout reproduce slowly because of a four to seven year sexual maturation period. They are a long-lived fish, with some known to live up to twelve years (U.S.Fish and Wildlife Service 1998). In the fall they seek out cold streams with clean gravel and cobble substrates on gentle gradients. Eggs hatch in late winter to early spring about four to five months after egg deposition. Fry hide in the substrate for several weeks prior to emergence (swimming up out of the gravel), at which time they continue to stay close to the bottom (Goetz 1989).

In addition to the above described relationships between various salmon species and their habitats, there are also interactions between the species that have evolved over the last 10,000 years such that the survival of one species might be enhanced or impacted by the presence of another. Pink and chum salmon fry are frequently food items of coho smolts, dolly varden, and steelhead (Hunter 1959). Chum fry have decreased feeding and growth rates when pink salmon juveniles are abundant (Ivankov and V. L. Andreyev 1971), probably the result of occupying the same habitat at the same time (competition). These are just a few examples. Most streams in Washington are home to several salmonid species, which together, rely upon freshwater and estuary habitat the entire calendar year. As the habitat and salmon review have indicated, there are complex interactions between different habitat components, between salmon and their habitat, and between different species of salmon. For just as habitat dictates salmon types and production, salmon contribute to habitat and to other species.

WATERSHED HISTORY

The original inhabitants of the Walla Walla River Basin included three Native American Tribes: the Cayuse, Walla Walla, and Umatillas. The tribes ceded the land to the United States in an 1855 treaty (Saul *et al.* 2000). Today the tribes collectively are known as the Confederated Tribes of the Umatilla Indian Reservation (CTUIR). Lewis and Clark's Corps of Discovery were the first Americans to visit the Walla Walla Basin, passing through in 1805. The Corps followed the Touchet River to the present day town of Dayton. The Touchet looked far different 195 years ago than it does today. Some excerpts from the journals of Lewis and Clark follow.

This is a description of the Touchet River near its confluence with the Walla Walla River:

> The hills of this creek are generally abrupt and rocky, but the narrow bottom is very fertile, and both possess 20 times as much timber as the Columbia itself; indeed, we now find, for the first time since leaving Rock fort [The Dalles], an abundance of firewood. The growth consists of cottonwood, birch, crimson haw, red and sweet willow, choke-cherry, yellow currants, gooseberry, the sumac, together with some corn-grass and rushes (Lewis and W.Clark 1893).

Another entry, this time near the present site of Prescott: ".…the bottoms of the creek widened into a pleasant country, two or three miles in extent. The timber is now more abundant, and our guide tells us that we shall not want either wood or game from this place as far as the Kooskooskee (Clearwater River, Idaho) (Lewis and W.Clark 1893)." Lewis and Clark returned to the east coast with reports that the climate, topography, and natural resources in the Walla Walla River Basin were conducive to settlement.

A scientist named Dice conducted vertebrate studies in the Touchet River Basin from 1904 to 1914. His findings were published in 1916 and incorporated in Mudd 1975. Some excerpts follow. "In most places along the Touchet River trees do not naturally grow more than a quarter of a mile from the stream, and often the width of the habitat is much less than this (Dice 1916, cited in Mudd 1975)."

> The cottonwood often makes very large trees with a height of 80 to 100 feet and with trunks three to four feet in diameter, but the other trees are much smaller. Under the trees there is nearly always a heavy growth of shrubby underbrush. A growth of shrubs also covers many small areas over which trees have not become dominant. Where the habitat has not been disturbed by man the thick tangle of smaller shrubs, thorns, and vines makes excellent refuges for birds and mammals (Dice 1916, cited in Mudd 1975).

Dice went on to say:

> The animal habitats of southeastern Washington have been greatly altered by the work of man. Farming is extensively carried on and in the prairie area a very large percentage of the land is under cultivation. Irrigation is also practiced in valleys of both the prairie and sagebrush areas. All of the land not under direct

> cultivation has been heavily grazed by cattle and stock. Part of the timber along the streams has been cut down and much of the brush has been cleared away….These changes in the environment have caused great changes in the abundance of the different species of vertebrates…. (Dice 1916, cited in Mudd 1975).

The average width of Touchet River riparian zones (below Dayton) measured by Mudd 1975 was about 50 feet.

Euro-American settlement and natural resource utilization of the Walla Walla River Basin evolved through four phases: trapping, livestock production, logging, and agriculture. Commercial trapping began in the early 1800s (Saul *et al.* 2000). Aquatic fur-bearers including beaver, otter, and muskrat were the quarry of choice. Competition between fur companies was intense with no concern shown for sustainability of fur-bearer populations. The Hudson's Bay Company had a virtual monopoly on the fur resources of the Columbia Basin. However, Company executives sensed they would lose access to the area because of the anticipated claim on the land by the United States. In an effort to obtain maximum profit and discourage American advancement toward the Columbia the Company carried out a "scorched earth" policy, trapping every beaver possible (Meinig 1968, Lichatowich 1999). The Hudson's Bay company trapped 20,000 beaver and otter in 1822 and 1823. Fur-bearer populations plummeted and commercial trapping in the region ceased around 1835. The fur companies faced with declining fur supplies decided to diversify operations in the Columbia Basin by raising livestock (Meinig 1968).

The Whitman Mission (near present day Walla Walla) began drawing settlers to the region at the same time. The first settlers generally felt that the uplands were unsuitable for grain production, and instead directed their efforts to livestock production along the river bottoms. Settlement and livestock production boomed when gold was discovered in Idaho in 1860. The settlers now had a market for cattle and sheep. Intense grazing (particularly by sheep) severely altered the landscape. Native perennial grasses were replaced by invasive annual grasses (Saul *et al.* 2000).

The Whitman Mission, established in 1836 was the first large-scale agricultural endeavor attempted in WRIA 32. Early agricultural production was confined to the lowlands, which were being fully utilized for agricultural production by the 1860s. Farmers were forced to experiment with dryland farming in the uplands, where they discovered that wheat produced very well (Saul *et al.* 2000).

A large influx of settlers in the 1880s created a demand for wood. Riparian forests had fairly extensive amounts of cottonwoods (especially along the Touchet River), but in comparison the nearby Blue Mountains were heavily timbered with coniferous trees (Lewis and W.Clark 1893, McKinney 1998). Early timber cruisers felt the timber supply in the Blue Mountains was inexhaustible. Logging activity was centralized in the Upper Touchet River Subbasin on the Cahill, Eckler, and Robinette Mountains, and Lewis Creek and the Wolf Fork Touchet River. Timber harvest averaged 13,000 board feet per day. Oxen and an 18-mile long flume from the upper Robinson Fork to the town of

Dayton were used to transport logs until 1900 (McKinney 1998). Early harvests focused on the most profitable trees, large Douglas-fir and Ponderosa pine. Harvest shifted to western larch, grand fir, white fir, and lodgepole pine once Douglas-fir and Ponderosa pine supplies were exhausted. Logs were commonly yarded across streams, destroying spawning grounds. Stream channels were also modified to reduce road construction costs (Van Cleve and Ting 1960). Clearcutting was the logging method of choice. Fires were suppressed, a practice that has changed in recent years (U.S. Forest Service (USDA) and Bureau of Land Management (USDI) 1997).

Cities and towns began appearing in the Walla Walla Basin around the 1860s. The city of Walla Walla was founded in 1858. At that time it was called "Waiilatpu." Waitsburg soon followed and had a population of 107 by 1869. Dayton was platted in 1872. The Walla Walla area was a popular site for settlement. By 1910 the population of Walla Walla had risen to 20,000 people. There was even talk of making Walla Walla the state capitol (Meinig 1968).

WATERSHED DESCRIPTION

Location

The Walla Walla River Basin is located in Southeast Washington and Northeast Oregon near the point at which the Columbia River turns southwest to form the Washington-Oregon border. This subbasin of the Columbia River Basin is bounded by the Columbia River to the west, Eureka Flat to the north, the Blue Mountains on the east, and the Horse Heaven Hills to the west. The watershed drains an area of approximately 1,758 square miles, approximately 73% of which is located within Washington State (Confederated Tribes of the Umatilla Indian Reservation *et al.* 1990, U.S. Army Corps of Engineers 1997). The Washington portion of the watershed is known as Water Resource Inventory Area 32 (WRIA 32). The subbasin encompasses portions of Walla Walla and Columbia Counties in Washington, and Umatilla, Cayuse, and Wallowa Counties in Oregon (Saul *et al.* 2000). See Map 1 in Appendix B. The average elevation of the Blue Mountains along the south and east rim of the basin is 5,000 feet with a maximum height of 6,000 feet at Table Mountain. The lowlands range in elevation from 300 feet near the mouth of the Walla Walla River to 2,500 feet at the base of the Blue Mountains (Saul *et al.* 2000).

Population and Ownership

According to 1994 U.S. Census Bureau estimates, the total population of the Walla Walla River Basin was approximately 45,740. About 76% of this population lived in the Walla Walla/College Place urban area. Approximately 90% of the basin is privately owned, with the Federal Government owning 9% and the states of Washington and Oregon owning the remaining 1% (U.S. Army Corps of Engineers 1997).

Geology

The Walla Walla River Subbasin is part of a larger geologic area known as the Columbia Plateau. This region has a dynamic geologic history. The earliest strata found in this area are sedimentary rocks that originated on the floor of the Pacific Ocean prior to being carried onto the North American Continent by tectonic activity. The sedimentary rock is overlain by several thousand feet of volcanic basalt. This rock was laid down in massive flood flows of molten lava that swept over the entire area, engulfing everything in its path (Alt and D. W. Hyndman 1995). The Columbia Plateau is actually a large basin ringed by mountains. It is theorized that the sunken region resulted from the immense weight of the basalt deposits compressing the lighter strata beneath. The basalt is overlain by loess soils. These soils are the result of glacial outwash carried from the Rocky Mountains by the Spokane Floods. These floods occurred as many an 100 times (about 16,000 years ago) when an ice dam blocked Idaho's Clark Fork River, forming Glacial Lake Missoula. The outwash was deposited near Wallula Gap on the Columbia River. Southwest winds then carried the loess to the Northeast where it now resides. The soil was deposited in dunes several hundred feet thick in many places, resulting in the rolling topography commonly referred to as the "Palouse." The Spokane floods also created the channeled scablands of the region (just north of the Snake River) (Busacca, A. J. 2000 Personal

Communication). Large quantities of gravel and fine sediment (the Touchet Formation) were deposited in the Walla Walla area when the floodwaters were pooled into huge lakes by the constriction at Wallula Gap on the Columbia River (Alt and D. W. Hyndman 1995).

Hydrology

Two aquifers are present in the watershed. A deep aquifer comprised of basalt layers hundreds of feet in thickness underlays the entire watershed. This aquifer contains a substantial amount of ground water (4 million acre-feet) flowing slowly through fractures in the rock. The aquifer is recharged by precipitation in the Blue Mountains. Approximately 2.6 million acre-feet are accessible for use from this aquifer. About 22,500 acre-feet are pumped to the surface each year (U.S. Army Corps of Engineers 1997). A gravel aquifer about 120,000 acres in size overlies the basalt aquifer from Milton-Freewater downstream to the town of Touchet. See Map 8 in Appendix B. A confining clay layer is sandwiched between the gravel and basalt aquifers (James *et al.* 1991). About 33% of the 3 million acre-feet of water stored in the gravel aquifer are available for use. About 25,000 acre-feet are pumped to the surface annually. Water levels in both aquifers appear to be declining (U.S. Army Corps of Engineers 1997). The gravel aquifer has substantial hydraulic continuity with the Walla Walla River (Pacific Groundwater Group 1995), which flows subsurface for 2.5 to 5 miles (depending on weather conditions) between the city of Milton-Freewater and the Washington-Oregon border during the summer months. This is partially caused by water loss to the gravel aquifer, but also a result of irrigation withdrawals upstream (Mendel, G. 2000 Personal Communication). Surface water from numerous streams in the Washington portion of the basin is over appropriated. These streams have been closed to further consumptive appropriations since 1977 (Washington State 1977). See Table 2.

Vegetation

Meinig (1968) and Saul *et al.* (2000) chronicle historical descriptions of vegetation in the Walla Walla Basin from the 1805 Lewis and Clark expedition through European settlement. These descriptions capture the influence of climate, topography, and human activities on vegetation composition and distribution throughout the basin. During this time period the lowlands were consistently described as dominated by shrubs, herbaceous plants, and grasses. Trees were rarely found on the lowlands except near streams. These riparian zones were dominated by deciduous species such as willow, cottonwood, birch, and alder (Dice 1916, cited in Mudd 1975; Meinig 1968; Saul *et al.* 2000). Wood (especially coniferous trees) was a precious resource for both the tribes and early European settlers. The indigenous tribes located their winter camps based on wood supply (Saul *et al.* 2000), while European settlers imported pine and fir from the Blue Mountains to build settlements in the lowlands (Meinig 1968). This lowland plant community has been attributed to fire management practiced by the Cayuse, Walla Walla, and Umatilla Tribes. Burning the prairies encouraged new growth of grasses for livestock forage and roots and berries for subsistence (Meinig 1968; Saul *et al.* 2000). Presently the native grasses, shrubs, and herbaceous plants are largely gone, replaced by irrigated crops in the lowlands and dry farmed crops on the plateaus. Tillage and or stubble burning have taken the place of fire management practiced by the tribes. Many of the slopes that are too steep to farm support grass and shrub communities that closely resemble those described in the historical accounts.

In the past the forests of the Blue Mountains were subject to periodic fires intentionally set by the tribes as a management tool (Saul *et al.* 2000) or ignited by lightning strikes. These fires removed young and diseased trees and prevented build up of fuel (dead limbs and leaf litter) on the forest floor. Fires usually remained in the understory of the forest consuming litter and young trees. Mature trees were protected by thick bark, height, and spatial separation. This led to low density stands of mature coniferous trees with an understory of berry-producing shrubs. The fire regime ensured long term forest cover in the highlands. High-grade logging removed the largest trees and left inferior trees behind for a seed source (Saul *et al.* 2000). Today the forests are managed for timber production and recreation. Fire suppression and past logging activities have resulted in dense stands of immature conifers with large amounts of litter on the forest floor. These thick stands are more susceptible to disease and catastrophic crown fires than the mature forests of the past (U.S. Forest Service (USDA) and Bureau of Land Management (USDI) 1997). Clearcuts and forest fires have the potential to leave large areas of the uplands devoid of mature vegetation, increasing the likelihood of erosion and landslides (mass wasting) that can have serious impacts on fish populations.

Landuse and Salmonid Habitat Conditions

Agriculture is the primary component of the Walla Walla Basin economy. Agricultural lands comprise 58% of the watershed, while forest land and range land cover 25% and 17% respectively (U.S. Army Corps of Engineers 1997). Management of agricultural lands has seriously degraded salmonid habitat in many areas of the watershed. Practices such as farming to the edge of streams, cutting down riparian vegetation, filling off-channel areas, diking and channelization, allowing livestock full access to streams, conversion of native perennial vegetation to annual crops, and irrigation have all played roles in habitat degradation (Bureau of Reclamation 1997; U.S. Army Corps of Engineers 1997; Mendel *et al.* 1999; Saul *et al.* 2000). See Map 7, Map 8, and Map 9 in Appendix B. In several areas irrigation water management practices reduce streamflow to a trickle or eliminate it all together. Poor riparian zone condition and stream flows reduced by irrigation combine with high summer air temperatures to raise water temperatures far above the tolerance level of salmonids during the summer months (Mendel *et al.* 1999; Mendel *et al.* 2000). Dryland agricultural fields managed with conventional tillage and summer fallow practices yield prodigious amounts of sediment to streams via sheet and rill erosion during the winter months. See Figure 1 below. Forest management has made significant contributions to habitat degradation as well (USDA Soil Conservation Service *et al.* 1984; Saul *et al.* 2000). The impacts of urban areas such as the cities of Walla Walla, College Place, and Milton-Freewater are not well documented. Impervious surfaces (buildings, parking lots and roads) likely discharge contaminated runoff to streams and alter hydrologic patterns. Floodplain development, channelization of streams, and municipal water use are important habitat altering processes as well. Urban areas are a small portion of the WRIA when compared to agricultural land, but their impacts are considerable. Negative impacts should be rectified wherever possible.

The Washington Department of Fish and Wildlife (WDFW) estimates that less than 10% of surface water diversions in the Washington portion of the basin meet state or federal juvenile fish screening criteria. About 80% or more of diversions are screened, but in most cases the sole purpose of screens is to keep debris out of the irrigation system. Very few if any screens are designed specifically to prevent juvenile salmonids from entering the irrigation system. Roughly 80% of gravity diversions identified in the WDFW Cooperative Compliance Review Program (CCRP) are unscreened, with the exception of major gravity diversions that are screened to meet old criteria, but often do not meet current state or federal juvenile fish screen criteria. Over 75% of the diversions identified in the CCRP are located in streams utilized for salmonid spawning, rearing and migration. The high incidence of non-compliant surface water diversions is a serious threat to federally listed juvenile salmonids. It is likely that the diversions identified in the CCRP may represent only 50% to 60% of surface water diversions currently in use in the Washington portion of the basin. The majority of diversions (85%) are pumps. A high proportion of unidentified diversions are believed to be present in residential areas of the cities of College Place and Walla Walla. It is likely that a significant portion of these diversions may be unpermitted illegal water withdrawals with no water rights. The number and location of surface water diversions identified through the CCRP and referenced in this report are based on preliminary information gathered from cooperator applications and subject to change as individual site assessments are completed (Bireley 2000).

Figure 1. Mud on Hwy. 125 washed off the conventionally tilled field to the right during an early October 2000 rainstorm. Note the field to the left that is farmed with no-till methods.

Table 2. WRIA 32 Streams (Washington State) Closed to Further Consumptive Appropriations. Source: (Washington State 1977).

Stream	*Affected Reach*	*Effective Date of Closure*	*Period of Closure*
Blue Creek	Mouth to Headwaters	Date of Adoption	June 1-Oct. 31
Mill Creek	Mouth to Stateline	02/06/1957	May 1-Oct. 1
Walla Walla River	Mouth to Stateline	Date of Adoption	May 1-Nov. 30
Dry Creek	Mouth to Headwaters	Date of Adoption	April 15-Nov. 15 or whenever Walla Walla River at USGS Gage 14.0185 drops below 91.0 cfs.
Touchet River	Mouth to Headwaters	Date of Adoption	June 1-Oct. 31
Coppei Creek	Mouth to Headwaters	Date of Adoption	April 1-Nov. 10
Doan Creek	Mouth to Headwaters	Date of Adoption	June 1-Oct. 1
Mud Creek (Walla Walla Tributary)	Mouth to Headwaters	Date of Adoption	May 1-Oct. 31 or whenever Walla Walla River below confluence with Mud Creek falls below 50 cfs.
Pine Creek	Mouth to Headwaters	Date of Adoption	May 1-Oct. 31 or whenever Walla Walla River at confluence with Pine Creek or below Touchet River drops below 50 cfs.
Stone Creek	Mouth to Headwaters	Date of Adoption	May 1-Oct. 31

Note: Date of Adoption was 12/14/1977.
* Exception for single-domestic and stock water where no other practical source is available.

STOCK STATUS OF SALMONIDS

Spring Chinook Salmon

Spring chinook *(Oncorhynchus tshawytscha)* were historically present in the Touchet River and its four forks (North Fork, South Fork, Wolf Fork, and Robinson Fork) and the Walla Walla River including its South Fork. Historic accounts do not give an estimate of run size, however they do describe the Walla Walla River Subbasin as a "good" producer of spring chinook (Nielson 1950; Northrop 1999). These fish migrated upstream in May and early June. Irrigation withdrawals, dams, and diversions took a toll on the species. Low flows and or channel dewatering commonly coincided with the upstream migration of spring chinook, which entered the river during the worst conditions possible for migration — the irrigation season. Spring chinook had to contend with low flows, diversions and dams that hindered passage, and high water temperatures. A 2.5 to 5 mile (depending on weather conditions) stretch of the mainstem Walla Walla River near the stateline known as the "Tumalum Branch" has gone dry during the summer months annually since 1880, while the lower five miles of the Touchet River are commonly reduced to a series of isolated pools during the summer irrigation season. Anecdotal accounts point to Nine Mile Dam (completed in 1905) at River Mile (RM) 9 on the mainstem Walla Walla River as being the death knell for spring chinook in the basin. This structure was an effective, though not complete barrier to upstream migration. The last significant run of spring chinook in WRIA 32 was observed in 1925 (Nielson 1950).

The last sport catches of spring chinook in the Walla Walla Basin were reported by the Oregon Game Commission in 1955 (18 fish) and 1956 (35 fish) (Van Cleve and Ting 1960). Spring chinook are now extinct in the Walla Walla River Subbasin (Confederated Tribes of the Umatilla Indian Reservation *et al.* 1990; Mendel *et al.* 1999; Northrop 1999). The Confederated Tribes of the Umatilla Indian Reservation (CTUIR) recently initiated an attempt to reintroduce spring chinook to the Walla Walla River Basin. About 200 pairs of sexually mature spring chinook from the Ringold Hatchery near the Tri-Cities, Washington were released into the South Fork Walla Walla River and Mill Creek (Oregon portion) on August 8, 2000. It is hoped that these fish will establish a naturally spawning population. At this point in time, the project is largely an experiment to see if habitat conditions in the Walla Walla River will allow spring chinook to recolonize. A few spring chinook have been observed in the Walla Walla and Touchet Rivers in recent years. Since 1991 a few fall chinook have been observed in the lower Walla Walla River on several occassions (Mendel, G. 2001 Personal Communication).

Summer Steelhead/Rainbow Trout

Summer steelhead/rainbow trout *(Oncorhynchus mykiss)* were ubiquitous throughout the Walla Walla River Basin historically. Changes in flow regimes, riparian conditions, water temperatures, substrate, and passage impediments have had a less dramatic effect on steelhead runs than spring chinook. One possible explanation for this is the difference in upstream migration timing. Steelhead begin entering the Walla Walla system as early as September or October, but if necessary they will hold for long periods of time until conditions are favorable for migration (Bjornn and Reiser 1991). They then spawn in the

Spring, typically in March and April. By November flows have increased substantially, barriers are passable, and water temperatures have declined (Fulton 1970; Saul *et al.* 2000). Steelhead are still found throughout much of their historic range in the WRIA, though populations have declined. Accurate historic estimates of steelhead returns to the Walla Walla River Basin don't exist, but the run size is believed to have been 4,000 to 5,000 fish (Oregon Department of Fish and Wildlife 1987), cited in Confederated Tribes of the Umatilla Indian Reservation *et al.* 1990). Presently steelhead are found in the Walla Walla River including the North and South Forks and several of their tributaries, Mill Creek and several of its tributaries, Dry Creek, and the Touchet River including the North and South Forks, Wolf Fork, Robinson Fork, Spangler Creek, Lewis Creek, Jim Creek, Patit Creek, and Coppei Creek (Germond, J. 2000b Personal Communication; Mendel, G. 2000 Personal Communication; Northrop, M. 2000 Personal Communication; Volkman, J. 2000 Personal Communication).

The Washington Department of Fish and Wildlife (WDFW) plants marked (adipose fin clip) hatchery steelhead in the Touchet River at Dayton and the Walla Walla River below Mill Creek to provide sportfishing opportunities (Mendel, G. 2001 Personal Communication). Only marked fish may be retained. All "unmarked" wild fish must be released unharmed. Oregon does not release hatchery steelhead in the Walla Walla River. All hatchery fish captured at the Nursery Bridge weir (in Milton-Freewater) are presumed to be strays from the Touchet and Walla Walla River plants and are killed to protect the genetics of the wild steelhead spawning in the North and South Forks of the Walla Walla River (U.S. Army Corps of Engineers 1997). Summer steelhead in this basin are part of the Middle Columbia River Evolutionarily Significant Unit (ESU) as defined by the National Marine Fisheries Service (NMFS). These fish were listed as threatened under the Endangered Species Act (ESA) on March 25, 1999 (National Marine Fisheries Service 1999) Table 3. See Map 11 in Appendix B.

Bull Trout

Historically Walla Walla Basin bull trout *(Salvelinus confluentus)* likely migrated throughout the mainstem (possibly as far downstream as the Columbia River) and tributaries, but dams and diversions throughout the basin have disrupted bull trout migration and may cause genetic isolation of the three populations of Walla Walla Basin bull trout (Buchanan *et al.* 1997). Today isolated populations are found in the headwaters of the North and South Forks of the Walla Walla River, Mill Creek, North Fork Touchet River, Wolf Fork, and South Fork Touchet River. Migration is restricted to times when adequate flows are present, generally from fall to late spring (Buchanan *et al.* 1997). The U.S. Fish and Wildlife Service (USFWS) listed bull trout as a threatened species in June of 1998 (U.S.Fish and Wildlife Service 1998) Table 3. See Map 12 in Appendix B.

Mountain Whitefish

After several years of extensive sampling in the Washington portion of the Walla Walla Watershed, mountain whitefish *(Prosopium williamsoni)* appear to have low population levels, limited distribution, and low reproduction (Mendel, G. 2001 Personal Communication).

Walla Walla River Fish Rescue

Prior to the summer of 2000, two diversion dams in Milton-Freewater, Oregon removed all the flow from the mainstem Walla Walla River for a period of roughly June 1 through September 30. This left the "Tumalum Branch" dewatered for a distance of 2.5 to 5 miles. The Confederated Tribes of the Umatilla Indian Reservation (CTUIR) and Oregon Department of Fish and Wildlife (ODFW) have conducted several fish rescue operations as flows begin to diminish in this reach. The year 2000 rescue efforts (a cooperative of CTUIR, ODFW, and Walla Walla River Irrigators) recovered an estimated 3,500 juvenile rainbow trout/steelhead and 15 bull trout juveniles from this stretch. Juvenile rainbow/steelhead rescued in April through June are suspected to be outmigrating smolts and are released below the dewatered reach, while juvenile rainbow/steelhead captured later in the year are assumed to be rearing. The rearing fish are released above the dewatered reach where flow conditions are more favorable (Germond, J. 2000b Personal Communication). In the spring of 2000 the U.S. Fish and Wildlife Service reached an agreement with Hudson's Bay Improvement District and Walla Walla River Irrigation District (both located in Milton-Freewater, Oregon) to leave 13 cubic feet per second (cfs) of water flowing over the Nursery Street Bridge Diversion Dam in Milton-Freewater, Oregon. Gardena Farms Irrigation District (located in Washington) was also part of the agreement, agreeing to leave 10 cfs flowing over the Burlingame Diversion (located Southwest of Walla Walla, Washington). The bypass flows left by irrigators in 2000 under the above agreement have reduced the amount of dry channel to about 1 mile in length, however the additional mile of newly watered channel has only minimal surface water with very little flow. Preliminary estimates place an additional 2 to 3 cfs in the channel at the stateline (Neve, W. 2000 Personal Communication).

Table 3. Steelhead, Bull Trout and Exotic Fish Presence and Habitat Use by Stream Reach.

Stream Name	Summer Steelhead	Bull Trout	Mountain Whitefish	Brown Trout	Smallmouth Bass	Largemouth Bass	Channel Catfish	Bullheads	Tadpole Madtom
Upper Touchet Subbasin									
N.F. Touchet: Headwaters to Lewis Creek	K,SR	K,SR	K	P					
N.F. Touchet: Lewis Creek to Wolf Fork	K,SR	K,SR	K	K					
N.F. Touchet/ Touchet: Wolf Fork to L/C Trail State Park	K,SR	K,SR	K	K	K*				
Wolf Fork: Headwaters to Whitney Creek	K,SR	K,SR		K					
Wolf Fork: Whitney Creek Downstream	K,SR	K,SR		K					
Robinson Fork	K,SR								
S.F. Touchet: Griffin Fork to mouth	K,SR			P					
S.F. Touchet: Griffin, Burnt, Green Forks	K,SR	K,SR							
Lower Touchet Subbasin									
Touchet: L/C Trail State Park to Coppei Creek	K,SR			K	K				
Touchet: Coppei Creek to Hwy. 125	K,M			K	K				
Coppei Creek	K,SR								
Touchet: Hwy. 125 to mouth	K,M				K		K		

* Downstream from Dayton

Table 3. Continued.

Stream Name	Summer Steelhead	Bull Trout	Mountain Whitefish	Brown Trout	Smallmouth Bass	Largemouth Bass	Channel Catfish	Bullheads	Tadpole Madtom
Lower Walla Walla Subbasin									
Walla Walla: Stateline to Mill Creek	K,SR	K,M	K						
Walla Walla: Mill Creek to McDonald Rd.	K,SR	K,M			K		K		
Walla Walla: McDonald Rd. to mouth	K,M				K	K	K	K	K
Pine & Mud Creeks	K,M				P	P	P	P	
Dry Creek: Headwaters to Hwy. 12 at Smith Rd.	K,SR								
Dry Creek: Hwy. 12 at Smith Rd. to mouth	K,M								
Mill Creek: Bennington Lake Dam to mouth	K,SR	K,M							
Garrison Creek	K,SR								
Yellowhawk Creek	K,SR								
Cottonwood, Russell, & Reser Creeks	K,SR								

Table 3. Continued.

Stream Name	Summer Steelhead	Bull Trout	Mountain Whitefish	Brown Trout	Smallmouth Bass	Largemouth Bass	Channel Catfish	Bullheads	Tadpole Madtom
Upper Mill Creek Subbasin									
Mill Creek: Headwaters to Bennington Lake Dam	K,SR	K,SR	K						
Mill Creek Tribs. (USFS)	K,SR	K,SR							
Oregon Walla Walla Subbasin									
Walla Walla: Forks to Stateline	K,SR	K,M							
N.F. Walla Walla (USFS)	K,SR	K,SR							
S.F. Walla Walla (USFS)	K,SR	K,SR							
S.F. Walla Walla Tribs. (USFS)	K,SR	K,SR							

HABITAT LIMITING FACTORS IDENTIFICATION

This report was developed by synthesizing written habitat descriptions, data derived from field assessments of habitat, and personal communications from natural resource professionals with knowledge of the Walla Walla Watershed. Many of these personnel served in various capacities on the Technical Advisory Group (TAG) which contributed large amounts of literature, data, and technical review to this project. This report is intended for use as a tool to guide and prioritize salmonid habitat restoration projects within the Walla Walla Watershed. Habitat descriptions, assessments, and TAG knowledge were used to describe the current habitat conditions on river reaches throughout the watershed. These descriptions were compared to the WRIA 32 salmonid habitat rating criteria (Table 5), resulting in a good, fair, or poor rating for habitat quality averaged throughout the length of each river reach (Table 6). **"Screens and Diversions" will be rated POOR because of the estimated 90% noncompliance rate with juvenile fish screening criteria discussed under Landuse and Salmonid Habitat Conditions, unless information is available that proves screens are in compliance. In addition, "Biological Processes" will receive a FAIR rating at best because of a lack of anadromous fish carcasses and a depressed beaver population throughout the watershed.** The habitat descriptions and ratings were used to develop prioritized recommendations for each subbasin in this report (Table 7) . These recommendations are not intended as regulatory mandates. They are actions that are necessary to restore salmonid populations in the Walla Walla Watershed. Implementation of some of the recommendations will require creative thinking, compromise, and in some cases sacrifices. It should be up to the people living in the watershed to decide whether or not these recommendations will be implemented. Salmon recovery in the Walla Walla Watershed will not be successful unless the public supports the restoration efforts.

Habitat Limiting Factors Assessed

Fish Passage

Artificial obstructions including dams and culverts can block salmonid migration up and down streams. Depending on the location and longevity of the barrier, the negative effect may be limited to a portion of only one generation, or in extreme cases the barrier may cause the extinction of an entire run of fish. Frequently encountered structures that may hinder salmonid migration in WRIA 32 include gravel push-up dams, concrete dams, and failed culverts. See Figure 2 below.

Figure 2. Culvert at the Larch Street crossing on Garrison Creek. Photo taken February 2001.

Screens and Diversions

At least 280 points of diversion (PODs: pumps or gravity diversions drawing water from streams, not ditches or canals) are present in the Oregon portion of the Walla Walla Watershed (Justus, T. 2001 Personal Communication). The Washington Department of Fish and Wildlife has identified 417 diversions (both pump and gravity) for inclusion in the Cooperative Compliance Review Program. This count includes diversions identified by landowners who voluntarily requested assistance. There are likely many more diversions in use that are not accounted for (Bireley 2000). Diversions can take a serious toll on salmonid populations during the juvenile portion of the life history. Juvenile salmonids seek out off-channel areas for rearing habitat. These areas typically provide hiding cover from predators, calmer water, and abundant food sources. The opening to a gravity diversion closely resembles an off-channel area. Juvenile salmonids may swim into this entrance if it is not blocked by a proper screen. From this point the fish may get trapped, become an easy meal for predators, or get sucked up in irrigation equipment and pumped onto a field. Pump style diversions also need adequate screening to ensure that juvenile salmonids are not sucked into the irrigation system.

Riparian Condition

Riparian zones are the interface between the aquatic and terrestrial environments. This zone is normally covered with lush vegetation ranging in composition from grasses and forbs to shrubs and large trees depending upon the location within a watershed. Historically riparian zones in the Walla Walla River Basin were dominated by large cottonwood trees in the lower river reaches. Coniferous trees such as pine and fir began to dominate as one progressed closer to the Blue Mountains (Mudd 1975). Riparian zones have several important functions in maintaining natural riverine processes. Tree and shrub roots hold streambanks together with a “root matrix.” This matrix stabilizes channels, enabling the formation of undercut banks (excellent fish habitat) and reduces erosion (fine sediment smothers juvenile salmonids developing in streambed gravels). Overhanging tree canopies shade water, maintaining the cool temperatures salmonids need to thrive. Leaf litter falling into the stream is an important component of primary production within the aquatic community. Insects feed on the decomposing leaves, and fish in turn feed on the insects. Mature trees in the riparian zone also provide important function when they are knocked into streams by windthrow or landslides. These woody materials are known as large woody debris (LWD). Large woody debris stabilizes streambeds and banks, captures spawning gravels, encourages pool formation, provides resting and hiding cover for salmonids, and creates habitat for insects and other forage important to salmonids. Finally vegetation within the riparian zone filters soil and pollutants from stormwater runoff and reduces flood damage by slowing down flood waters, thereby dissipating energy and capturing soil carried in the flood waters. See Figure 3 below.

Figure 3. Riparian vegetation along the South Fork Walla Walla River on Bureau of Land Management Lands. Photo taken January 2001.

Streambank Condition

Natural streambank stability maintains the integrity of river processes. Riparian zones can maintain or repair themselves if they are located on a stable bank. Vegetation has a difficult time recovering from flood damages or other disturbances if it is continually undermined by a failing bank. Stable streambanks also ensure an adequate channel depth. A given volume of water is deeper in a narrow channel than in a very wide channel. This depth maintains the cool temperatures and hiding cover needed by salmonids. Eroding streambanks also contribute large amounts of fine sediment to the water column. See Figure 4 below. Fine sediment makes it difficult for adult salmonids to breathe and smothers juvenile salmonids hiding in the gravel on the bottom of streams. Once the sediment settles to the bottom it cements gravels and cobbles together forming a type of "pavement." This pavement makes it difficult for female salmonids to excavate their nest or redd. An abundance of fine sediment reduces the amount of water able to circulate through the gravel deposited over the eggs in the redd. This water infiltration is critical to oxygen delivery to the developing salmon and removal of fish wastes from the nest.

Figure 4. Birch Creek upstream from Powerline Road showing both highly unstable vertical banks and very stable riprap bank protection that is of little value to salmonids. Photo taken January 2001.

Floodplain Connectivity

Floodplains provide an area for dissipation of energy in flood waters. The floodplain has a larger surface area, and generally flatter slope than the stream channel. Once flood waters spill onto the floodplain, the water spreads out and loses energy. Collisions between water and riparian vegetation reduce energy even further. See Figure 5 below. Water slows down and sediment settles out, gradually building up the floodplain. Water also seeps into the groundwater table, recharging wetlands, off-channel areas and shallow aquifers. Off-channel areas provide juvenile salmonids an ideal rearing environment. Fewer predators are present here than in the main river channel. Juvenile salmonids expend less energy living in the calm waters than would be required to fight the current of the river. This energy savings along with an abundance of food enables juvenile salmonids to grow very rapidly. Wetlands and aquifers in turn release water to the stream during the summer months through a process called hydraulic continuity. Functional floodplains moderate instream flow peaks and valleys through the process of water storage and release. This maintenance of flow ensures adequate water for salmonids during the summer months, and reduces the possibility of high energy flood events that destroy salmonid redds.

Figure 5. Walla Walla River downstream from Milton Freewater, OR 1965. Flood waters burst through the dikes attempting to reestablish a meandering channel and reclaim the floodplain. Photo courtesy of U.S. Army Corps of Engineers, Walla Walla District.

Width/Depth Ratio

The width/depth ratio refers to the average width of the river channel at a given cross-section divided by the average depth at that same cross-section. In other words it determines if the channel is wide and shallow (high width/depth ratio) or narrow and deep (low width/depth ratio). In general a narrow deep channel is more favorable to salmonids than a wide shallow channel. The deep water provides hiding cover and maintains cool water temperatures. While shallow water provides little or no cover (depending upon the life stage) and tends to gather heat with the expansive surface area exposed to the sun. The width/depth ratio also provides clues about a river's current state of channel evolution. A low width/depth ratio indicates a stable channel that has reached the end point of channel evolution, or possibly an unstable channel that is downcutting rapidly in response to channel disturbances elsewhere within the watershed. Conversely a very high width/depth ratio usually indicates unstable streambanks and rapid deposition of sediments. This situation might naturally occur at a river outlet or delta area, or it could be a response to channel disturbances upstream or downstream (Rosgen 1996). See Figure 6 below.


Figure 6. Birch Creek below Powerline Road showing a narrow width/depth ratio caused by highly unstable banks. Photo taken January 2001.

Substrate Embeddedness

Substrate embeddedness is the product of fine sediment washed into streams. Soil eroded from cropland, forestland, urban developments, and dirt roads is the main source of fine sediment inputs to streams in the Walla Walla Basin. However, unstable stream banks also make significant contributions. Ideal salmonid spawning habitat would have very little substrate embeddedness. See Figure 7 below. High substrate embeddedness makes redd (salmonid nest excavated in gravel) construction difficult, impairs water infiltration through the gravel, and reduces survival of eggs and incubating juvenile salmonids.

Figure 7. Clean-unembedded gravel provides excellent salmonid spawning habitat.

Large Woody Debris

Large woody debris or (LWD) is an important component of stream habitat. Large trees that fall into streams, or are carried in by landslides and floods stabilize streambeds, collecting spawning gravels and encouraging pool formation. Woody debris also provides cover for salmonids and their prey. See Figure 8 below. In the past woody debris was removed to aid navigation, transport logs downstream, speed flood waters downstream, or remove barriers to salmonid migration. Large woody debris is lacking in many streams because of these activities. Unfortunately woody debris recruitment is a long-term process since it requires the presence of a functioning riparian zone comprised of numerous large trees.

Figure 8. Large woody debris jam on the South Fork Walla Walla River on Bureau of Land Management Lands. Photo taken January 2001.

Pool Frequency

Pools are important habitat for salmonids and their prey. Salmonids use pools for resting during migration, and juvenile rearing. Pools are characterized by calm water and can range in size from one foot deep and a few feet of surface area to 10 feet or greater in depth with a substantial surface area depending upon the size of the stream.

Pool Quality

Important features of pools are size, depth, and cover (instream and overhead). Generally speaking the more size, depth, and cover that are present the higher the quality of the pool. Large-deep pools with lots of cover provide many hiding areas, ample forage, and cool water temperatures. An abundance of pools interspersed with riffles combine to create ideal salmonid habitat. See Figure 9 below.

Figure 9. Quality pools are deep (up to waist in this case) and have instream and overhead cover. The rootwad provides both types of cover in this case. Photo courtesy of Ben Tice, USACE, Walla Walla District. Photo taken 1999.

Off-Channel Habitat

Beaver ponds, wetlands, and oxbow ponds connected to river channels are all forms of off-channel habitat. Juvenile salmonids (especially coho salmon, rainbow/steelhead trout, and cutthroat trout) seek out this type of habitat for rearing. Off-channel areas provide an abundance of food with fewer predators than would typically be found in the river. These areas also have sluggish flows and large amounts of vegetative and woody cover, allowing rearing salmonids to hide from predators and conserve energy. See Figure 10 below. Diking, and channelization of rivers, conversion of riparian zones to agricultural land, and floodplain development all play a roll in destruction of off-channel habitat.

Figure 10. Beaver ponds provide excellent off-channel rearing habitat for salmonids. Today beaver populations are depressed in the Walla Walla Basin.

Water Quality/Temperature

Salmonids require cold and clean water for optimal survival. Temperature, dissolved oxygen (DO) concentration, total suspended solids (TSS), pH, and other water chemistry are all important elements of water quality. Water temperature requirements vary depending upon salmonid lifestage, but in general a range of 50-65°F (10-21°C) is preferred (bull trout need even colder water in the range of 36-54°F (2-12°C)). Long-term exposure to temperatures greater than 75°F (24°C) is fatal to salmonids (Bjornn and Reiser 1991). Salmonids require a minimum dissolved oxygen concentration of 5 mg/L (also read as [ppm] or parts per million) for survival (Bjornn and Reiser 1991). Washington State water quality standards require a value of 8 mg/L of dissolved oxygen for protection of fish resources in Class A or better waters. Total suspended solids (TSS) refers to the weight of particles including soil, and algae suspended in a given volume of the water column (Michaud 1991). The U.S. Fish and Wildlife Service recommends a maximum TSS level of 80 mg/L to protect salmonid fishes. Total suspended solids levels in the Touchet River frequently are far in excess of this value (Saul *et al.* 1999). Other water quality parameters including pH (the concentration of hydrogen ions in water), and chemical pollution can degrade habitat quality.

Water Quantity/Dewatering

Water quantity is a major limiting factor in the Walla Walla Basin. The basin has a semi-arid climate with the majority of precipitation occurring in the winter months. Stream flows are dependent on the snow pack in the Blue Mountains (Saul *et al.* 2000). The summer months bring naturally low stream flows that are reduced substantially by irrigation water withdrawals. In several reaches streams are reduced to a trickle or completely dewatered. If flows are too low or channels are completely dewatered, little or no quality habitat remains for salmonids. As flows decrease, water temperatures increase. Migration is hindered or completely blocked and fish are more vulnerable to predation. See Figure 11 below.

Figure 11. Mill Creek above Gose Road during summer low flows. Fish cannot migrate through this reach, so those present likely perish from high water temperatures or predation. Photo taken summer 2000.

Change in Flow Regime

A change in flow regime refers to the current flow conditions affected by human management versus the natural flow conditions that were present in the watershed prior to Euro-American settlement. In some basins it is rather easy to identify a change in flow regime with stream flow data. Unfortunately, large scale surface water withdrawals began in the Walla Walla Watershed around the 1860s (Saul *et al.* 2000) far earlier than the earliest stream flow data measured in the basin (1914 and later). It is possible to infer that a change in flow regime has occurred on many reaches because water is removed for irrigation purposes and fish that were historically present are now extinct. However it is not possible to determine the magnitude of the flow regime change.

Biological Processes

Biological processes include the presence of introduced plant or animal species that may have a negative effect on salmonids (i.e. reed canary grass, brown trout, smallmouth bass) as well as the absence of native species that were historically present such as beaver and spring chinook salmon. Introduced fish species may out-compete, hybridize with, or eat native salmonids. Introduced plants and noxious weeds can out-compete native vegetation, reducing the quality of riparian plant communities. The removal of species can disrupt ecosystem functions. For example, beaver historically impounded many portions of streams in the watershed. Beaver ponds are excellent salmonid rearing habitat and they gradually release water to streams, helping to maintain summer flows. Large numbers of anadromous salmonids returning from the ocean are a valuable source of nutrients to the upper portions of watersheds which are often nutrient limited. Nutrients from decomposing salmon carcasses are a critical component of the aquatic food chain. Anadromous fish populations are depressed, therefore anadromous fish carcasses are well below historic levels in Walla Walla Basin streams (Mendel, G. 2000 Personal Communication). See Figure 12 below.

Figure 12. Decomposing anadromous fish carcasses provide ocean-derived nutrients to freshwater ecosystems.

UPPER TOUCHET SUBBASIN HABITAT LIMITING FACTORS

Upper Touchet Subbasin Description

The Upper Touchet Subbasin encompasses the Touchet River headwaters originating high in the Blue Mountains (elevation 4,000-5,000 feet) downstream to the City of Dayton (population approx. 2,500), Washington. See Map 2 in Appendix B. Forestry is the dominant landuse with some dryland farming on high plateaus and irrigated agriculture in the valley bottoms. Cattle ranching, recreational cabins, and small acreage home sites are also present in the subbasin (Mendel, G. 2000 Personal Communication). The largest population center is the city of Dayton at the lower end of the subbasin. This subbasin is home to approximately 312 stream-road crossings, with 92 miles of road within 100 feet of streams and 207 miles of road within 300 feet of streams (McFarlane 2000). The Upper Touchet drainage is characterized by very deep v-shaped valleys carved by streams downcutting through extensive deposits of Columbia River Basalts. The topography leads to high to moderate stream gradients that convey episodic high energy flows following heavy precipitation or rain-on-snow events (Saul *et al.* 1999). The entire Touchet River has been closed to further consumptive appropriations of surface water from June-1 through October-1 (Washington State 1977). Habitat conditions in the Upper Touchet, though not pristine, are more favorable to salmonids than those found in the Lower Touchet.

Salmonid bearing streams in the subbasin include the North Fork Touchet, Spangler Creek, Lewis Creek, Jim Creek, Wolf Fork, Robinson Fork, Coates Creek, Whitney Creek, the South Fork Touchet and its forks (Griffin, Burnt, and Green). Summer steelhead, resident rainbow trout, and bull trout are currently present in this subbasin. Spring chinook were historically present here, but have been extinct since the early 1930’s. The Upper Touchet Subbasin is one of three primary areas of relatively high quality salmonid habitat remaining in WRIA 32. Significant amounts of spawning and rearing occur throughout this subbasin downstream to Dayton. Spawning and rearing are known to occur from Dayton downstream to Waitsburg, but at reduced levels (Mendel, G. 2001 Personal Communication). The Touchet River from Waitsburg downstream is primarily a migration corridor. However, some winter rearing of salmonids likely occurs downstream to Prescott (TAG 2000 Personal Communication). See Map 11 and Map 12 in Appendix B.

Upper Touchet Subbasin Common Habitat Characteristics

Instream Habitat

Large woody debris (LWD) is lacking in nearly all reaches of the Upper Touchet Subbasin. The lack of wood is caused by widespread riparian zone degradation and removal of large wood from channels in flood control efforts (TAG 2000 Personal Communication). An associated impact of the low LWD loads is a lack of pool habitat.

Biological Processes

Beavers were historically present in large numbers throughout Southeast Washington (Lewis and W.Clark 1893); Meinig 1968; Saul *et al.* 2000). Beaver ponds provide off-channel habitat, maintain wetlands, recharge shallow aquifers, and moderate stream flow regimes (Lichatowich 1999). The beaver population in the Walla Walla Basin (and throughout Southeast Washington) was nearly exterminated by fur trappers by 1835 (Meinig 1968). The low beaver population in the Walla Walla Basin is being evidenced today by a lack of off-channel habitat, few wetlands, and stream flow regimes with high winter peaks and low summer flows (and associated high temperatures). Although some beaver are present, there are not enough to create or maintain the salmonid habitat that was historically present in the Walla Walla Basin (Saul *et al.* 2000). However, many riparian zones in the watershed are degraded and likely could not support a thriving beaver population. In fact a beaver reintroduction effort would likely cause considerable damage to existing functional riparian zones and young plants being established in restoration efforts. Beaver populations will likely naturally increase as riparian zones are restored throughout the Walla Walla Basin.

Anadromous fish runs in the Upper Touchet are currently returning in numbers far below historical abundance. The steelhead run is characterized as "depressed" by the Washington Department of Fish and Wildlife (Washington Department of Fisheries and Washington Department of Wildlife 1993) and federally listed as threatened (National Marine Fisheries Service 1999). Spring chinook have been extinct since 1950 (Mendel *et al.* 1999). A lack of anadromous fish carcasses is suspected to be a significant factor limiting productivity in the Upper Touchet Subbasin (Mendel, G. 2000 Personal Communication).

North Fork Touchet River (Headwaters to Lewis Creek, including tributaries)

Habitat Ratings

Fish Passage

No artificial obstructions have been identified on this reach of the North Fork Touchet River (Northrop 1998, Reckendorf, F. and Tice 2000). A road crossing over the lower end of a tributary of Spangler Creek is a barrier (Mendel, G. 2000 Personal Communication). In addition, four barriers were identified on small tributary streams. These barriers include an irrigation water intake near the mouth of Lewis Creek and a failed culvert at about RM 0.5 on Ireland Gulch, a small LB tributary of Lewis Creek (TAG 2000 Personal Communication). A culvert on "Bluewood Creek" near the Bluewood Ski resort may be a passage barrier and a stream crossing on "Corral Creek," (tributary of N.F. Touchet) is a juvenile passage barrier (Mendel, G. and D.Karl 2000 Personal Communication).

Screens and Diversions

Preliminary data from the WDFW CCRP identified two gravity diversions and one pump diversion in use on this reach (Bireley 2000). Most diversions on this reach are used to irrigate small lawns, not for watering agricultural crops (Tice, B. 2001 Personal Communication). A diversion dam into a private pond located on Lewis Creek (about 200 yards above the mouth) obstructs upstream and downstream migration at most flows. A significant amount of under utilized productive habitat is available above this barrier (TAG 2001 Personal Communication).

Riparian Condition

A large portion of the reach is located on U.S. Forest Service (USFS) lands. In general riparian vegetation is composed of a diverse mixture of native trees and shrubs, providing adequate shade and large woody debris (LWD) recruitment on USFS lands. Forest Road 64 parallels the river along much of the reach (Lynch 1995, Northrop 1998). Average canopy cover was 66.7% (Lynch 1995). The riparian zone on USFS lands is intact except in areas where the USFS road is in close proximity to the river. Access roads and several dwellings have reduced riparian vegetation as well (Mendel, G. and D.Karl 2000 Personal Communication, Tice, B. 2001 Personal Communication). The grazing allotment on USFS lands along this reach has been vacant since 1965 (Lynch 1995). Very little livestock is present in the riparian zone on private lands (Tice, B. 2001 Personal Communication). The riparian zone along the lower 1.5 miles of Spangler Creek is dominated by mature and second growth Douglas-fir with an understory of alder and cottonwood. Average canopy closure was 20 to 30%, shading about 26% of the stream (U.S. Forest Service (USDA) 1994c). The riparian zone along Lewis Creek is composed of large white fir, grand fir, and alder (U.S. Forest Service (USDA) 1994b)

Streambank Condition

Banks along this reach are relatively stable. Bank stability on private lands averaged 75% (Viola 1997, Reckendorf, F. and Tice 2000). Areas of erosion were associated with logging and public roads encroaching on stream channels (Tice, B. 2001 Personal Communication). Banks along Spangler Creek are stable with only 30' of instability noted in 1.5 miles of stream assessed (U.S. Forest Service (USDA) 1994c). Several areas along Lewis Creek have unstable banks. This bank instability has been attributed to a private road that runs along several miles of the lower portion of the creek (Mendel, G. 2001 Personal Communication).

Floodplain Connectivity

The stream is predominately a "B" type channel (moderate entrenchment with slope 2-4%) allowing flood flows to inundate the floodplain on USFS lands (Northrop 1998). Forest Road 64 runs adjacent to a large portion of the stream and is having some negative effects on floodplain function (Mendel, G. and D.Karl 2000 Personal Communication). Some downcutting of the channel is occurring on private lands. Very large cottonwoods are present on the floodplain adjacent to the downcut channel (Tice, B. 2001 Personal Communication).

Width/Depth Ratio

The February 1996 flood did a considerable amount of damage to streams throughout WRIA 32. The North Fork Touchet was not immune to this phenomenon. Viola (1997) recorded a width/depth ratio of 38.2 at Hompegg Falls (about 2 miles upstream from Lewis Creek). Tributary streams and the North Fork Touchet above Hompegg Falls appear to have withstood the flood better than reaches downstream. Width/depth ratios on USFS lands upstream from the falls range from 10 to 15 (Lynch 1995, Northrop 1998). The width/depth ratio of Spangler Creek was 8.8 (U.S. Forest Service (USDA) 1994c). Width/depth ratio of Lewis Creek was 8.5 (U.S. Forest Service (USDA) 1994b).

Substrate Embeddedness

Substrate embeddedness values ranged from 23 to 26% for the portion of the North Fork Touchet on USFS lands (Lynch 1995, Northrop 1998). Spangler Creek was less embedded with a value of 15% (U.S. Forest Service (USDA) 1994c). Embeddedness on Lewis Creek averaged 23% (U.S. Forest Service (USDA) 1994b). Data was not available for this parameter on the North Fork Touchet River below Hompegg Falls.

Large Woody Debris

Large woody debris quantities averaged 47.7 pieces per mile on USFS lands (Lynch 1995), but quantities are reduced on private lands downstream with 5.5 pieces per mile reported by Reckendorf and Tice (2000). LWD quantities on Spangler Creek are slightly lower than those on the North Fork Touchet with an average of 36.3 pieces per mile (U.S. Forest Service (USDA) 1994c). Lewis Creek has large quantities of LWD on USFS lands with 168 pieces per mile counted during a 1994 survey (U.S. Forest Service (USDA) 1994b). However, LWD is greatly reduced downstream on private lands (Mendel, G. 2001 Personal Communication).

Pool Frequency

The 1996 flood does not appear to have altered pool frequency. Prior to the flood, pools comprised 10.8% of stream surface area with an average spacing of 23.7 pools per mile on USFS lands (Lynch 1995). Northrop (1998) documented 24 pools per mile on USFS lands. Viola (1997) measured pools occupying 1.24% of stream surface area below the USFS boundary. Reckendorf and Tice(2000) measured 23.4 pools per mile also below the USFS boundary. Pools comprised 1.7% and 3.0% of stream surface area on Spangler and Lewis Creeks respectively. The average frequency of pools per mile was 7.6 and 11.0 for Spangler and Lewis Creeks respectively (U.S. Forest Service (USDA) 1994c, U.S. Forest Service (USDA) 1994b). Functional riparian zones and adequate amounts of large woody debris should encourage natural pool formation. However pools are lacking in quality and quantity. The lack of pools is caused by channel disturbances including removal of large woody debris and instream work performed following flood events (TAG 2000 Personal Communication) as well as channel constrictions that minimize sinuosity (Mendel, G. and D.Karl 2000 Personal Communication).

Pool Quality

Quality pools (>3 ft. deep with lots of surface or subsurface cover) are lacking throughout this reach (Lynch 1995, Viola 1997, Northrop 1998, Reckendorf, F. and Tice 2000). Pools typically average about 1 ft. in depth and lack cover (Lynch 1995, Viola 1997).

Off-Channel Habitat

Off-channel habitat would not typically be found in abundance in a reach of this nature (2-4% gradient), but some is present. Lynch 1995 reported 1.7% of stream surface area as side channels and two large marshes, while Northrop (1998) reported existence of some ponds and backwater areas.

Water Quality/Temperature

Water temperatures in this reach are the best found within the Touchet River Basin. This is one of the primary factors enabling the Touchet River bull trout subpopulation to persist, while habitat conditions downstream have degraded to the point of severely hampering bull trout rearing (Mendel, G. and D.Karl 2000 Personal Communication). Average temperatures in the North Fork Touchet River near "Bluewood Creek," Spangler Creek, Lewis Creek and the North Fork Touchet River all remained below 55°F during the summer months in 1999 and 2000. Maximum temperatures rarely exceeded 55°F (Mendel *et al.* 2000; Mendel and Karl 2000). Bull trout juvenile rearing temperature requirements were used to rate water temperature on this reach. Chemical pollution may be a problem in "Bluewood Creek," a small tributary of the North Fork Touchet River near the Bluewood Ski area. An orange substance in the substrate was observed in this stream during fish population studies conducted by WDFW in July and August 1999 (Mendel, G. 2000 Personal Communication). Water quality on Lewis Creek may be compromised by numerous cabins and homes with septic systems (Mendel, G. 2001 Personal Communication).

Water Quantity/Dewatering

Dewatering does not occur on this reach (TAG 2000 Personal Communication). Some surface water diversions are present including the one on Lewis Creek (Mendel, G. and D.Karl 2000 Personal Communication).

Change in Flow Regime

The natural flow regime appears to be present (TAG 2000 Personal Communication).

Biological Processes

Brown trout are likely present in this reach (Mendel, G. and D.Karl 2000 Personal Communication). See following section and Upper Touchet Subbasin Common Habitat Characteristics for additional details.

North Fork Touchet River (Lewis Creek to Wolf Fork, including tributaries)

Habitat Ratings

Fish Passage

A culvert on Ireland Gulch, a LB tributary of Jim Creek is a probable barrier (TAG 2000 Personal Communication). Numerous small dams that would pose fish passage problems were identified by USFS personnel on the portion of Jim Creek flowing through private lands (U.S. Forest Service (USDA) 1994a).

Screens and Diversions

Preliminary data from the WDFW CCRP identified one gravity diversion and three pump diversions in use on this reach of the North Fork Touchet River (Bireley 2000). These diversions are used for irrigated agriculture, livestock watering, and watering large lawns (Tice, B. 2001 Personal Communication).

Riparian Condition

Riparian buffers along this reach of the North Fork Touchet River are generally narrow with some native trees present to provide shade. In most cases livestock is not present in the riparian buffer (Reckendorf, F. and Tice 2000). Portions of the historic riparian forest have been converted to cropland, pastures, and home sites (Tice, B. 2001 Personal Communication). The riparian zone along Jim Creek is dominated by Douglas-fir with a dense understory of alder, grasses and forbs. Canopy closure ranged from 31 to 60% (U.S. Forest Service (USDA) 1994a).

Streambank Condition

Viola (1997) documented an average of 47.5% of banks eroding, while Reckendorf and Tice(2000) measured 33.4% erosion of banks assessed. Banks along Jim Creek are stable with only 46 feet noted as unstable in 1.2 miles of stream assessed (U.S. Forest Service (USDA) 1994a). Straightening of the stream channel and removal of riparian vegetation and LWD are the likely causes of bank erosion (Tice, B. 2001 Personal Communication).

Floodplain Connectivity

Some gravel dikes constructed after the 1996 flood are limiting floodplain connectivity. A road along the lower end of Jim Creek also constricts the floodplain (TAG 2000 Personal Communication). Stream channel modifications along with removal of LWD and riparian vegetation may have caused downcutting of the channel (Tice, B. 2001 Personal Communication).

Width/Depth Ratio

This reach of the North Fork Touchet is excessively wide and shallow as evidenced by a mean width/depth ratio of 56.4 following the 1996 flood (Viola 1997). Jim Creek had a width/depth ratio of 8.9 (U.S. Forest Service (USDA) 1994a).

Substrate Embeddedness

Data on substrate embeddedness on this reach of the North Fork Touchet River is not available, but it is likely the same or worse than the reach upstream (Mendel, G. and D.Karl 2000 Personal Communication). Embeddedness on Jim Creek averaged 33% (U.S. Forest Service (USDA) 1994a).

Large Woody Debris

Large woody debris (LWD) is deficient in this reach. Reckendorf and Tice(2000) measured 15.2 pieces of LWD per mile on this reach. LWD is more common on Jim Creek with 33.5 pieces per mile counted by the USFS (U.S. Forest Service (USDA) 1994a). Although floods have recruited LWD, the TAG (2000) attributes lack of LWD to removal of wood from the channel in flood control efforts, lack of functional riparian zones, and loss of access to the floodplain caused by dike construction, channel downcutting, and roads (Mendel, G. and D.Karl 2000 Personal Communication, Tice, B. 2001 Personal Communication).

Pool Frequency

Pools are lacking on this reach. Viola (1997) measured a mean pool surface area of 0.45%, while Reckendorf and Tice(2000) documented 14.3 pools per mile. Many small pools are present on Jim Creek, with an average of 19.4 pools per mile, occupying 2.5% of stream surface area (U.S. Forest Service (USDA) 1994a). Natural pool formation has been disrupted by the removal of LWD and instream work associated with flood control activities (TAG 2000 Personal Communication). Many of the pools on this reach are formed by the stream contacting bedrock at the base of canyon walls (Tice, B. 2001 Personal Communication).

Pool Quality

Where present, pools on this reach averaged about 1.2 ft. in depth with some cover (Viola 1997, Reckendorf, F. and Tice 2000). Natural pool formation has been disrupted by removal of LWD and instream work (including bank armoring) associated with flood control activities as well as road location and maintenance (TAG 2000 Personal Communication).

Off-Channel Habitat

A limited amount of off-channel habitat exists on this reach (TAG 2001). Grazing activity increases as one moves downstream.

Water Quality/Temperature

Maximum temperatures on the North Fork Touchet River frequently exceeded 60°F to 70°F with average temperatures 55° to 60°F from mid June to mid September. Maximum temperatures on Jim Creek frequently exceeded 60°F during the summer months, and the average temperature was ≥55°F from mid June to late August (Mendel *et al.* 2000; Mendel and Karl 2000). Bull trout juvenile rearing temperatures were used to rate water temperature on this reach.

Water Quantity/Dewatering

Dewatering does not occur on this reach (TAG 2000 Personal Communication), but withdrawals are present and summer flows are low (Mendel, G. and D.Karl 2000 Personal Communication).

Change in Flow Regime

Surface water diversions likely reduce summer streamflows (Mendel, G. and D.Karl 2000 Personal Communication).

Biological Processes

Brown trout introduced for recreational purposes beginning in July 1965 by the Washington Department of Game (now Washington Department of Fish and Wildlife) are present in this reach of the North Fork Touchet. This species feeds on insects and small fish, including both juvenile bull trout and steelhead (Mendel, G. and D.Karl 2000 Personal Communication). The brown trout stocking program was discontinued in 1999 because of potential impacts on federally listed salmonids (Mendel *et al.* 2000). Reproductive success of the brown trout population is limited and the population is small, but composed of some individuals 6 to 8 pounds in size (Mendel, G. 2000 Personal Communication). See Upper Touchet Subbasin Common Habitat Characteristics.

North Fork Touchet/ Touchet River (Wolf Fork to Lewis & Clark Trail State Park, including tributaries)

Habitat Ratings

Fish Passage

Five partial channel spanning barriers were identified (U.S. Army Corps of Engineers 1997). One full channel spanning barrier is the surface water intake for the WDFW steelhead acclimation pond in Dayton. The other four barriers are believed to be gravel push-up dams. These structures may hinder migration during certain stream flows (TAG 2000 Personal Communication).

Screens and Diversions

Preliminary data from the WDFW CCRP identified five gravity diversions and 17 pump diversions in use on this reach of the Touchet River (Bireley 2000).

Riparian Condition

Some mature trees are present, but often in a narrow buffer. In many areas this buffer is disconnected from the river by dikes or fragmented by agricultural land conversion practices. A good example of the historic riparian plant community can be viewed at Lewis and Clark Trail State Park at the lower end of this reach. A forest buffer several hundred feet wide, dominated by large cottonwood and pine trees with a thick shrub understory is present at the park (TAG 2000 Personal Communication, Kuttel 2001).

Streambank Condition

Viola (1997) reported 47.5% of banks assessed in this reach were eroding. These areas are likely unarmored banks that are being attacked by the increased velocity caused by channel modifications and bank armoring. Dikes and riprap bank armoring are commonplace along a large portion of this reach from just upstream of the South Fork Touchet River mouth downstream to the State Park (Kuttel 2001). Channel straightening, removal of LWD, and destruction of riparian zones have likely contributed to the erosion problem. A large portion of stable banks are likely the result of dikes and bank armoring, not the natural stability of riparian vegetation (Tice, B. 2001 Personal Communication).

Floodplain Connectivity

A substantial amount of channelization, straightening, and diking in attempts to control flood waters has taken place in the reach from just above the mouth of the South Fork Touchet to downstream to the State Park (Kuttel 2001). At least 3.2 miles of this reach is constrained within dikes constructed in 1965 by the U.S. Army Corps of Engineers to protect the city of Dayton (U.S. Army Corps of Engineers 1997). An unknown length of private dikes are present along this reach. The city of Dayton is located on the floodplain of the Touchet River. Opportunities to reconnect the left bank floodplain along the North Fork Touchet exist from the Wolf Fork downstream to Baileysburg (just upstream from the South Fork confluence) (TAG 2000 Personal Communication).

Width/Depth Ratio

This reach is excessively wide and shallow as evidenced by a mean width/depth ratio of 70.7 following the 1996 flood (Viola 1997). Channel straightening and reshaping along with removal of LWD and riparian vegetation likely led to the wide-shallow streambed condition (Tice, B. 2001 Personal Communication). The channel condition leads to warm water temperatures, limits pool frequency and quality, and reduces fish cover.

Substrate Embeddedness

A significant amount of spawning habitat is available on this reach (Karl 2001). However, in some areas the stream has downcut close to bedrock (Tice, B. 2001 Personal Communication).

Large Woody Debris

Wood is often removed from the channel during flood control work and recruitment is limited by numerous dikes along this reach that separate riparian vegetation from the river (TAG 2000 Personal Communication). The extensive network of dikes, bank armoring, and straightened channel cause increased stream velocities which reduce the channel's ability to hold LWD (Tice, B. 2001 Personal Communication).

Pool Frequency

Pools are generally lacking on this reach. Viola (1997) measured pools comprising 2.79% of total water surface on this reach. Many of the pools present on this reach are caused by the stream contacting the base of bedrock hillsides (Tice, B. 2001 Personal Communication).

Pool Quality

When present, pools have an average depth of 1.12 ft. and an average of 1.35% surface cover (Viola 1997). Pools created by contact with bedrock walls often lack overhead and instream cover. Limited amounts of LWD, and highly altered streambanks significantly reduce pool cover as well (Tice, B. 2001 Personal Communication).

Off-Channel Habitat

Off-channel habitat is lacking along this reach. Agricultural land conversion, draining of wetlands, and dike construction have destroyed or disconnected off-channel areas from the main river channel (U.S. Army Corps of Engineers 1997, TAG 2000 Personal Communication).

Water Quality/Temperature

Maximum water temperatures on this reach of the Touchet River routinely exceeded 70°F with average temperatures ≥65°F from early July to mid August. Maximum water temperatures on the upper South Patit Creek frequently exceeded 65°F during the summer months, but the average temperature never exceeded 65°F. Temperatures downstream increased substantially with maximums frequently exceeding 70°F, and average temperatures >65°F from early July to mid August (Mendel *et al.* 2000; Mendel and Karl 2000). Numerous small tributaries, including intermittent streams are a significant source of fine sediment laden runoff that eventually makes its way to fish bearing streams in the Subbasin (Mendel, G. 2000 Personal Communication). The reach from the North/South Fork confluence downstream to Highway 12 in Dayton was listed on the 1998 303(d) list for water quality violations of ammonia, pH, temperature, fecal coliform, dissolved oxygen, and altered flow (Washington Department of Ecology 2000a).

Water Quantity/Dewatering

Dewatering does not occur, but diversions are present on this reach and upstream, reducing summer flows. Patit Creek often dewaters from the forks downstream during the summer months (TAG 2000 Personal Communication).

Change in Flow Regime

Surface water withdrawals and land management have likely changed the flow regime, but lack of historic flow data makes assessment of the extent of change impossible (TAG 2000 Personal Communication).

Biological Processes

Brown trout introduced for recreational purposes beginning in July 1965 by the Washington Department of Game (now Washington Department of Fish and Wildlife) are present in this reach of the North Fork Touchet. This species feeds on insects and small fish, including both juvenile bull trout and steelhead (Mendel, G. and D.Karl 2000 Personal Communication). The brown trout stocking program was discontinued in 1999 because of potential impacts on federally listed salmonids (Mendel *et al.* 2000). Reproductive success of the brown trout population is limited and the population is small, but composed of some individuals 6 to 8 pounds in size (Mendel, G. 2000 Personal Communication). See Upper Touchet Subbasin Common Habitat Characteristics.

Wolf Fork Touchet (Headwaters to Whitney Creek, including tributaries)

Habitat Ratings

Fish Passage

No manmade barriers were identified on this reach of the Wolf Fork (TAG 2001 Personal Communication). Several fords cross the channel, which is heavily used by spawning bull trout. Vehicles crossing the stream during the fall likely destroy many bull trout redds (TAG 2001 Personal Communication).

Screens and Diversions

There are no known diversions on this reach of the Wolf Fork (TAG 2001 Personal Communication).

Riparian Condition

The riparian zone on this reach is dominated by immature coniferous trees that appear to be about 40 years old. Alder and willow are also present. The riparian zone is nearly intact with the exception of a road that parallels the stream (TAG 2001 Personal Communication).

Streambank Condition

Streambanks on this reach of the Wolf Fork are very stable with the exception of road crossings (TAG 2001 Personal Communication).

Floodplain Connectivity

This area is very remote. McKinney (1998) identified approximately 4.5 miles of valley bottom road beginning at the mouth of Whitney Creek and continuing upstream. The road receives little use or maintenance and rarely isolates the stream from its floodplain, but it occasionally captures stream flow (Martin, S. 2001 Personal Communication).

Width/Depth Ratio

The width/depth ratio is estimated to be about 10 (Martin, S. 2001 Personal Communication) which is nearly ideal for streams of this size and gradient. The favorable width/depth ratio is attributed to stable banks and relatively intact riparian buffers (TAG 2001 Personal Communication).

Substrate Embeddedness

All sites measured by Martin (1992) were less than 30% embedded.   Ideally, embeddedness would be close to zero in this high-elevation tributary. Unfortunately, there are numerous intermittent and perennial streams that carry a significant amount of fine sediment laden runoff from clearcuts and logging roads in the uplands. The sediment eventually makes its way into the Wolf Fork (McKinney 1998).

Large Woody Debris

Upland timber harvest and channel cleanouts have resulted in a lack of LWD on this reach (TAG 2001 Personal Communication). Martin (1992) reported that less than 50% of pools measured contained woody debris, while 33% and 17% of run and riffle habitat, respectively contained LWD.

Pool Frequency

Pool habitat is lacking throughout this reach of the Wolf Fork, likely because of the near absence of LWD (TAG 2001 Personal Communication). Martin (1992) found that only 5.5% of his reach is comprised of pool habitat.

Pool Quality

The mean depth of pools measured by Martin (1992) in this reach was 1.7 feet. There was 100% overhead cover of plunge pools measured, while scour pools had only 43% overhead cover (Martin 1992). The predominant instream cover type was woody debris in scour pools and turbulence in plunge pools.   While woody debris was found in 50% of plunge pools measured, it comprised an average of only 25% of total cover (Martin 1992).

Off-Channel Habitat

Off-channel habitat is rare on this reach of the Wolf Fork (Martin, S. 2001 Personal Communication).

Water Quality/Temperature

In 1991, the maximum water temperature recorded in the Wolf Fork at Whitney Creek (approximately) by Martin (1992) was 55°F on August 25. During the summer of 1999 and 2000, the maximum water temperature at Newby's Cabin never exceeded 55°F (Mendel *et al.* 2000; Mendel and Karl 2000).

Water Quantity/Dewatering

Dewatering does not occur on this reach of the Wolf Fork (TAG 2001 Personal Communication).

Change in Flow Regime

Timber harvest and road construction in the upper basin have undoubtedly resulted in an unnatural flow regime in this reach (TAG 2001 Personal Communication).

Biological Processes

No exotic species are known to be present on this reach (TAG 2001 Personal Communication). See Upper Touchet Subbasin Common Habitat Characteristics.

Wolf Fork Touchet (Whitney Creek to mouth, including tributaries except Robinson Fork)

Habitat Ratings

Fish Passage

No manmade barriers were identified on this reach (TAG 2000 Personal Communication).

Screens and Diversions

Preliminary data from the WDFW CCRP identified three gravity diversions and two pump diversions in use on Wolf Fork (Bireley 2000).

Riparian Condition

The riparian zone on this reach is composed of some mature trees providing some shade. Damage caused by livestock access to the riparian zone increases as one moves downstream (Underwood *et al.* 1995; Tice, B. 2001 Personal Communication). McKinney (1998) described a lack of large woody debris except in the upper reaches on USFS land. The report also stated that the majority of the stream is lacking shade; 77% of streams in this Watershed Analysis Unit (WAU) lacking shade were Type 1 or 2 waters (fish bearing streams).

Streambank Condition

Stream banks on the Wolf Fork below Whitney Creek are highly unstable. McKinney (1998) reported banks actively eroding from the mouth to approximately RM 10.5. The report attributed channel instability to major flood events, and riparian degradation caused by logging and cattle grazing. Reckendorf and Tice(2000) observed erosion on 30.9% of banks assessed.

Floodplain Connectivity

The stream has access to the floodplain with the exception of areas where flood control work has taken place (Tice, B. 2001 Personal Communication).

Width/Depth Ratio

Unstable banks and flood events are causing rapid channel shifting, aggradation, and braiding of channels on the Wolf Fork. Viola (1997) reported a mean width/depth ratio of 44.52 following the 1996 flood. McKinney (1998) described channel braiding to RM 2.5 and again for 0.5 miles above the Robinson Fork confluence. Livestock access on the lower Wolf Fork has led to removal of riparian vegetation, and a wide-unstable channel (Tice, B. 2001 Personal Communication).

Substrate Embeddedness

According to McKinney (1998), the Wolf Fork receives fine sediment from debris flows originating in Type 4-9 channels (non fish bearing streams and intermittent streams) that eventually carry sediment to fish bearing streams. Embeddedness values range from 26-50% (Underwood *et al.* 1995). Erosion of logging roads is the most important management-related source of fine sediment carried to streams in the Wolf Fork Watershed. Over 30% of the logging roads are in valley bottoms (percentage includes South Fork Touchet). Surface erosion has increased sediment delivery 52% in the Wolf Fork over background levels (McKinney 1998).

Large Woody Debris

Large woody debris (LWD) is lacking throughout the Wolf Fork. LWD is commonly removed from channels during flood control work (TAG 2000 Personal Communication). The average abundance of LWD was 0.92 pieces per channel width (McKinney 1998). Riparian timber harvest, land clearing for agriculture, and stream "clean outs" in the South Fork Touchet have caused a net loss of LWD and poor near-term potential for recruitment throughout the watershed (McKinney 1998).

Pool Frequency

Pools are generally lacking throughout the Wolf Fork (McKinney 1998). Viola (1997) reported mean percent pool areas of 0.70% following the 1996 flood. Reckendorf and Tice(2000) measured 13.3 pools/mile, but felt this estimate may have been low because of intermediate stream flow conditions.

Pool Quality

Viola (1997) measured mean pool depths of 0.72 ft. following the 1996 flood. Reckendorf and Tice(2000) rated pool quality fair to poor. See RAPFAHRS in Appendix C.

Off-Channel Habitat

Off-channel habitat is rare in the Wolf Fork system (McKinney 1998).

Water Quality/Temperature

Maximum temperatures on the lower Wolf Fork frequently exceeded 60°F with averages rarely exceeding 55°F. Maximum temperatures on Coates Creeks frequently exceeded 55°F during the summers of 1999 and 2000, but average temperatures rarely exceeded this value (Mendel *et al.* 2000; Mendel and Karl 2000).

Water Quantity/Dewatering

Dewatering is generally not a problem on the Wolf Fork (TAG 2000 Personal Communication), but the lower Wolf Fork does have very low summer flows (Mendel, G. and D.Karl 2000 Personal Communication). The lower reach has been heavily impacted by livestock access. Riparian vegetation removal has resulted in an unstable channel up to 200' wide. The wide and unstable channel increases the severity of low summer flows (Tice, B. 2001 Personal Communication).

Change in Flow Regime

The excessively wide channel on the Wolf Fork below the Robinson Fork creates very low summer flows (TAG 2000 Personal Communication).

Biological Processes

Brown trout introduced for recreational purposes beginning in July 1965 by the Washington Department of Game (now Washington Department of Fish and Wildlife) are present in this reach. This species feeds on insects and small fish, including both juvenile bull trout and steelhead (Mendel, G. and D.Karl 2000 Personal Communication). The brown trout stocking program was discontinued in 1999 because of potential impacts on federally listed salmonids (Mendel *et al.* 2000). Reproductive success of the brown trout population is limited and the population is small, but composed of some individuals 6 to 8 pounds in size (Mendel, G. 2000 Personal Communication). See Upper Touchet Subbasin Common Habitat Characteristics.

Robinson Fork Touchet (including tributaries)

Habitat Ratings

Fish Passage

No manmade barriers are known to be present.

Screens and Diversions

No screens or diversions are known to be present on the Robinson Fork (TAG 2000 Personal Communication). Although an unscreened pond with stocked fish exists on a tributary (Mendel, G. 2001 Personal Communication).

Riparian Condition

Excessive grazing, forest practices, roads, and flood control work have degraded the riparian zone along the lower Robinson Fork (McKinney 1998, TAG 2000 Personal Communication, Mendel, G. and D.Karl 2000 Personal Communication). Cattle have access to nearly the entire stream channel (Tice, B. 2001 Personal Communication).

Streambank Condition

McKinney (1998) reported banks actively eroding from the mouth to approximately RM 4.0. Banks are unstable with the exception of reaches in the headwaters located above roads (Mendel, G. and D.Karl 2000 Personal Communication).

Floodplain Connectivity

A valley bottom road runs along the Robinson Fork to approximately RM 7.0, disrupting floodplain function (McKinney 1998, TAG 2000 Personal Communication).

Width/Depth Ratio

The channel is braided from the mouth about 0.5 miles upstream and is generally wide and shallow (Mendel, G. and D.Karl 2000 Personal Communication).

Substrate Embeddedness

Erosion of logging roads is the most important management-related source of fine sediment carried to streams in the Wolf Fork Watershed. Over 30% of the logging roads are in valley bottoms (percentage includes South Fork Touchet). Surface erosion has increased sediment delivery 309% over background levels in the Robinson Fork (McKinney 1998). High levels of fine sediment input suggest that substrate embeddedness could be a problem, but no information was found in the literature or upon questioning of TAG members.

Large Woody Debris

Large woody debris (LWD) is lacking throughout the Robinson Fork with the majority of pieces found in Type 4-9 channels (non fish bearing streams and intermittent streams). Large woody debris is commonly removed from channels during flood control work (TAG 2000 Personal Communication). LWD loads averaged 0.38 pieces per channel width (McKinney 1998). Reckendorf and Tice(2000) measured 19.0 pieces/mile.

Pool Frequency

Pools are lacking throughout the system, comprising an average of 7.1% total water surface area (McKinney 1998). Reckendorf and Tice(2000) counted 33.1 pools per mile with an average wetted channel width of 5 to 10 feet. Many pools on the Robinson Fork are formed below boulders (Tice, B. 2001 Personal Communication).

Pool Quality

The Robinson Fork is characterized by large cobble and boulder substrate. These large rocks provide some instream cover in pools, but LWD and overhanging riparian vegetation are sparse (Tice, B. 2001 Personal Communication). Reckendorf and Tice(2000) rated pool quality poor to fair. See RAPFAHRS in Appendix C.

Off-Channel Habitat

Land use activities and unstable channels prevent formation and maintenance of off-channel habitat (McKinney 1998). However, the Robinson Fork flows through a very narrow and steep valley where floodplain (and off-channel) areas would naturally be small in size (Tice, B. 2001 Personal Communication).

Water Quality/Temperature

Maximum water temperatures on the upper Robinson Fork frequently exceeded 60°F during the summer of 1999, with average temperatures >55°F from early July through late August (Mendel *et al.* 2000). Conditions deteriorated rapidly on the lower Robinson Fork with maximum temperatures frequently exceeding 70°F during the summers of 1999 and 2000 with average temperatures exceeding 60°F from early July through late August (Mendel *et al.* 2000; Mendel and Karl 2000). Numerous small tributaries, including intermittent streams are a significant source of fine sediment laden runoff that eventually makes its way to fish bearing streams in the Subbasin (McKinney 1998).

Water Quantity/Dewatering

Irrigation-induced dewatering is not an issue on the Robinson Fork since diversions are not in use (TAG 2000 Personal Communication), but summer flows are very low or subsurface in places during some years (Mendel, G. and D.Karl 2000 Personal Communication). Upland degradation caused by livestock grazing and logging have likely led to reduced water holding capacity (increased runoff) in this watershed (McKinney 1998, TAG 2001 Personal Communication).

Change in Flow Regime

The wide and shallow channel leads to low and/or subsurface flows during the summer months (McKinney 1998).

Biological Processes

See Upper Touchet Subbasin Common Habitat Characteristics.

South Fork Touchet River (Griffin Fork to mouth, including tributaries)

Habitat Ratings

Fish Passage

No manmade barriers are known on this reach. However, numerous fords cross the stream on the dirt road above the county road (Tice, B. 2001 Personal Communication, Kuttel 2001).

Screens and Diversions

Preliminary data from the WDFW CCRP identified one gravity diversion and three pump diversions in use on this reach of the South Fork Touchet River (Bireley 2000).

Riparian Condition

The South Fork Touchet lacks large woody debris (LWD) and shade, and has highly unstable channels; 67% of streams lacking shade were Type 1 or 2 waters (fish bearing streams). Grazing impacts have been noted along the mid and lower portions of this reach (McKinney 1998). Reckendorf and Tice(2000) characterized South Fork Touchet riparian zones as narrow buffers with minimal mature trees providing some shade. Riparian zones along the South Fork Touchet in the Rainwater Wildlife Area were comprised of immature coniferous trees. Canopy closure averaged 38%. Dozens of stumps 12 to 35 inches in diameter were noted in the floodplain (Childs 2001).

Streambank Condition

The South Fork Touchet River has serious bank erosion problems. Viola (1997) and Reckendorf and Tice(2000) observed 20% of banks eroding. Childs (2001) reported 37% of assessed banks actively eroding. In some cases eroded banks were 20 feet high. McKinney (1998) described channel incision occurring nearly everywhere (up to 6 ft. deep at stream confluences where large amounts of aggradation was occurring). The report also described channel instability as a problem on approximately 16 miles of banks. This channel instability has led to high amounts aggradation, creating streambeds dominated by highly mobile coarse sediment that are subject to frequent movement during high flows. This mobility prevents formation of stable pools and scours out or buries summer steelhead redds. Braiding and constriction by dikes and roads caused a reduction in stream length (sinuosity) of approximately 12% between 1937 and 1995 (McKinney 1998).

Floodplain Connectivity

Approximately 2.0 miles of valley bottom road between the Griffin Fork and the Dry Touchet disrupt floodplain function and disturb the streambed. Dikes, levees, and roads have disconnected the floodplain on other reaches as well (McKinney 1998, Childs 2001). An unimproved dirt road begins at the end of the county road along the South Fork Touchet River. This road allows access to several private cabins higher up in the valley. The road interferes with channel migration (McKinney 1998) and actually traverses a large portion of the active channel. There is a gate near the Dry Touchet, but the road between the gate and the end of the pavement is actually the streambed in several places.

Width/Depth Ratio

Unstable streambanks and shifting bedload have led to creation of a wide-shallow channel throughout much of the South Fork Touchet River. Viola (1997) calculated a mean width/depth ratio of 108 following the 1996 flood. McKinney (1998) describes channel braiding along the entire reach associated with an absence of streamside forests. Childs (2001) reported a width/depth ratio of 17.5 for the portion of the stream flowing through the Rainwater Wildlife Area.

Substrate Embeddedness

Although quantitative assessment of substrate embeddedness was not found in the literature, McKinney (1998) described substrate armoring as "difficult, in places, to penetrate with a boot toe." Fine sediment is contributed by debris flows in Type 4-9 channels (non fish bearing streams and intermittent streams), and agricultural fields on the plateaus. Erosion of logging roads is the most important management-related source of fine sediment carried to streams in the South Fork Touchet. Over 30% of the logging roads are in valley bottoms (percentage includes Wolf Fork Touchet). Surface erosion has increased sediment delivery 35% in the Upper South Fork and 65% in the Lower South Fork over background levels. Quantitative data was not available, but it was felt that agricultural operations could be contributing a significant amount of fine sediment to the South Fork Touchet River (McKinney 1998).

Large Woody Debris

Large woody debris (LWD) is uniformly absent or lacking in all areas of the South Fork Touchet River except Type 4-9 channels (non fish bearing and intermittent streams). Large woody debris pieces per channel width averaged 0.50 (McKinney 1998). Reckendorf and Tice(2000) found similar conditions with 9.4 pieces of LWD per mile. Childs (2001) reported 15 pieces of LWD per mile on the Rainwater Wildlife Area. Riparian timber harvest, land clearing for agriculture and homes, and removal of wood from the channel in the South Fork Touchet have caused a net loss of LWD and poor near-term potential for recruitment throughout the watershed. (McKinney 1998, Childs 2001).

Pool Frequency

Pools are lacking in the South Fork Touchet except in Type 4-9 channels (non fish bearing streams and intermittent streams) where large woody debris (LWD) is present to encourage pool formation (McKinney 1998). Viola (1997) measured a mean percent pool area of 3.16%. Reckendorf and Tice(2000) recorded 14.6 pools per mile. Childs (2001) observed 9 pools per mile on the Rainwater Wildlife Area.

Pool Quality

Where present, pools are transient as a result of unstable channels (McKinney 1998). Pools are also generally shallow as evidenced by Viola (1997) which reported a mean pool depth of 0.75 ft. A general lack of LWD coupled with highly mobile streambed sediment leads to a shortage of quality pool habitat (Childs 2001).

Off-Channel Habitat

Off-channel habitat is nearly nonexistent on the South Fork Touchet River. Roads, dikes, and shifting channels are limiting formation and or maintenance of off-channel areas. A large beaver dam complex was present on the lower South Fork prior to the 1996 flood (McKinney 1998), but it was completed destroyed by the flood (Tice, B. 2001 Personal Communication).

Water Quality/Temperature

Summer water temperatures on the South Fork Touchet River are not favorable to salmonids. The maximum water temperature in the summer of 1999 frequently exceeded 70°F and reached 80°F on several occasions. Average temperatures were ≥65°F from early July to early August (Mendel *et al.* 2000; Mendel and Karl 2000, Washington State University 2000). Numerous small tributaries, including intermittent streams are a significant source of fine sediment laden runoff that eventually makes its way to fish bearing streams in the subbasin (McKinney 1998).

Water Quantity/Dewatering

Dewatering occurs on the lower mile of the South Fork Touchet during the summer months (TAG 2000 Personal Communication). This dewatering does not occur during juvenile or adult salmonid migration to and from the ocean respectively, but it impairs movement of juveniles rearing in the system. There are other areas with wide channels and little or no riparian vegetation that have little or no flow present in summer (Mendel, G. and D.Karl 2000 Personal Communication, Tice, B. 2001 Personal Communication).

Change in Flow Regime

Low and/or subsurface summer flows indicate that the flow regime has likely changed (Mendel, G. 2000 Personal Communication). Irrigation withdrawals, a highly unstable channel, lack of riparian vegetation, and reduced floodplain connectivity are all potential contributors to the low flows.

Biological Processes

Brown trout introduced for recreational purposes beginning in July 1965 by the Washington Department of Game (now Washington Department of Fish and Wildlife) are present in this reach of the South Fork Touchet. This species feeds on insects and small fish, including both juvenile bull trout and steelhead (Mendel, G. and D.Karl 2000 Personal Communication). The brown trout stocking program was discontinued in 1999 because of potential impacts on federally listed salmonids (Mendel *et al.* 2000). Reproductive success of the brown trout population is limited and the population is small, but composed of some individuals 6 to 8 pounds in size (Mendel, G. 2000 Personal Communication). See Upper Touchet Subbasin Common Habitat Characteristics.

Griffin, Burnt, and Green Forks Touchet River (Headwaters to mouth, including tributaries of each stream)

Habitat Ratings

Fish Passage

No artificial obstructions are known to occur in these streams (TAG 2000 Personal Communication, Childs 2001). The Confederated Tribes of the Umatilla Indian Reservation (CTUIR) removed a collapsed log bridge on the Griffin Fork in the summer of 2000 (Childs 2001).

Screens and Diversions

No screens or diversions are known to be in use in these streams (TAG 2000 Personal Communication, Childs 2001). Some recreational cabins are present in this area, but no surface water diversions are in use (Tice, B. 2001 Personal Communication).

Riparian Condition

All three systems are dominated by small to medium size conifers. Shade was lacking on the Green Fork to RM 1.0 and on the Burnt Fork to RM 2.0 (McKinney 1998). The riparian plant community on the Griffin Fork is composed of grasses, forbs, shrubs, and immature trees. Only 14% of trees measured were greater than 12 inches diameter at breast height (dbh). Dozens of 12 to 35 inch dbh stumps were noted within the floodplain (Childs 2001). A road along the Green Fork reduces riparian vegetation and function (Mendel, G. 2001 Personal Communication).

Streambank Condition

Streambank condition has been degraded from logging, recreational activity, and road building (TAG 2000 Personal Communication). Approximately 17% of assessed banks on the Griffin Fork were actively eroding. Eroded banks with heights up to 8 feet were observed (Childs 2001). Banks along the upper Burnt Fork are relatively stable (Mendel, G. and D.Karl 2000 Personal Communication).

Floodplain Connectivity

The Griffin Fork *had* 2.5 miles of valley bottom road, while the Green Fork has 1.0 mile of valley bottom road (McKinney 1998). Valley bottom roads along the Griffin and Green Forks constrict floodplains (Childs 2001, Mendel, G. and D.Karl 2000 Personal Communication). In the summer of 2000, CTUIR removed 1.5 miles of the draw bottom road along the Griffin Fork (Childs 2001).

Width/Depth Ratio

The Griffin and Green Forks are wide and shallow, while the Burnt Fork is relatively narrow with adequate depth (Childs 2001, Mendel, G. and D.Karl 2000 Personal Communication). The Griffin Fork had a width/depth ratio of 20. Logging activities and grazing have led to increased runoff and decreased channel stability (Childs 2001).

Substrate Embeddedness

Erosion of logging roads contributes fine sediment to these streams (McKinney 1998, Childs 2001), but the steep gradients create high stream velocities that transport the sediment downstream to the South Fork Touchet River (Tice, B. 2001 Personal Communication).

Large Woody Debris

Large woody debris (LWD) is lacking in the mainstems of all three streams. Pieces per channel width were as follows: Green Fork 0.35, Burnt Fork 0.40, Griffin Fork 0.26 (McKinney 1998). Logging, removal of wood from channels, and degraded riparian zones have all contributed to a lack of LWD in these streams with the exception of the USFS and DNR portions of the Burnt Fork (Mendel, G. and D.Karl 2000 Personal Communication). The CTUIR placed approximately 100 whole trees with rootwads in the stream channel and floodplain of the Griffin Fork in the summer of 2000 (Childs 2001).

Pool Frequency

Pools are infrequent in the mainstems of all three streams. Water surface areas comprised of pools were as follows: Green Fork 11.2%, Burnt Fork 9.9%, Griffin Fork 7.5% (McKinney 1998). Childs (2001) reported 7.9 large pools per mile (≥1.6' deep with some cover) on the Griffin Fork. The lack of pool habitat on the Griffin Fork is attributed to altered watershed processes including degraded riparian zones and low LWD recruitment (Childs 2001). Pools are relatively common on the upper Burnt Fork located on USFS and DNR lands (Mendel, G. and D.Karl 2000 Personal Communication).

Pool Quality

Quality pool habitat is limited by low quantities of LWD (Childs 2001).

Off-Channel Habitat

The average gradients of these streams is over the 2% maximum gradient used to identify areas of off-channel habitat (McKinney 1998). This category was not applicable.

Water Quality/Temperature

Spot measurements revealed an average maximum temperature on the Griffin Fork during August 1999 of 55°F (Childs 2001). Numerous small tributaries, including intermittent streams are a significant source of fine sediment laden runoff that eventually makes its way to fish bearing streams in the subbasin (McKinney 1998). A large portion of sediment entering these streams originates from development associated with roads, and logging (Mendel, G. and D.Karl 2000 Personal Communication). Long-term temperature trend data are not available for these streams (TAG 2001 Personal Communication).

Water Quantity/Dewatering

Dewatering does not occur on these reaches, but the Green Fork has very low summer flows (TAG 2000 Personal Communication, Childs 2001).

Change in Flow Regime

The natural flow regime has been altered by upland timber harvest that has altered runoff timing and magnitude of peak flows. These systems have become "flashy," very sensitive to high intensity runoff such as occurs during rain-on-snow events (Childs 2001). A lack of historic flow data makes it impossible to assess the magnitude of the flow regime changes.

Biological Processes

No exotic plant or animal species are known to occur in this area (TAG 2000 Personal Communication). See Upper Touchet Subbasin Common Habitat Characteristics.

UPPER TOUCHET SUBBASIN RECOMMENDATIONS

1. Restore riparian zones on private lands. Where necessary (particularly the South Fork Touchet River, Robinson Fork, and lower Wolf Fork) utilize bioengineering techniques to stabilize portions of the channel to allow young riparian vegetation to get established.
2. Place LWD in streams to provide instream cover and encourage pool formation.
3. Conduct a comprehensive inventory of surface water diversions and ensure compliance with juvenile fish screening regulations, and where possible purchase surface water rights for instream flow enhancement.
4. Restrict access to the unimproved dirt road above the end of the county road along the South Fork Touchet River. Options should be explored to build a road that provides access to the private cabins but does not interfere with the stream.
5. Educate landowners about the importance of natural stream functions and the habitat requirements of subbasin salmonids.
6. Restore floodplain connectivity where possible, particularly from the Wolf Fork downstream to Lewis and Clark Trail State Park.
7. Any new logging roads should be built on ridgetops. Abandoned roads should be decommissioned and replanted with native vegetation.
8. Protect existing quality salmonid habitat through utilization of incentive programs, easements, or land purchases.
9. Gather water quality data (not just temperature measurements) on salmonid bearing streams.
10. Restrict access to stream fords on the Wolf Fork above Whitney Creek.
11. Repair the plugged culvert on Tate Creek to reduce sediment delivery to the Wolf Fork.
12. Protect critical bull trout spawning and rearing habitat on the upper North Fork, Wolf Fork, and Burnt Forks of the Touchet River.
13. Enforce landuse regulations including the Growth Management Act, Shoreline Management Act, and Critical Area Ordinances.

LOWER TOUCHET SUBBASIN HABITAT LIMITING FACTORS

Lower Touchet Subbasin Description

The Lower Touchet Subbasin includes the Touchet River and all tributaries downstream from the city of Dayton (population approx. 2,500). See Map 3 in Appendix B. Other population centers in this subbasin include the cities of Waitsburg (population approx. 1,000), Prescott (population approx. 300), and Touchet (population approx. 410) (U.S. Army Corps of Engineers 1997). This portion of the Touchet flows through a wide valley bottom walled in by gently rolling "Palouse" hills. The stream has a large floodplain that today is being used for agricultural production of crops such as alfalfa, peas, and wheat. The uplands are farmed intensively. Winter and spring wheat are the primary crops, with smaller acreages planted to peas, canola, mustard, and lentils. Approximately 730 stream-road crossings occur in the subbasin with 250 miles of road within 100 feet of streams and 470 miles of road within 300 feet of streams (McFarlane 2000). Habitat conditions in the Lower Touchet Subbasin are not as favorable to salmonids as those found in the Upper Touchet Subbasin. The entire Touchet River has been closed to further consumptive appropriations of surface water from June-1 through October-1 (Washington State 1977). See Table 2. Low flows caused by irrigation withdrawals from June-1 through October-1 and a lack of functioning riparian zones create passage and thermal barriers to migrating salmonids and also reduce rearing habitat substantially (Saul *et al.* 1999; Mendel *et al.* 1999; Mendel *et al.* 2000).

Poor habitat conditions have reduced this subbasin to primarily a migration corridor from the mouth to Waitsburg, although some limited steelhead spawning (March through May) and rearing (November through May) take place from just downstream of Waitsburg to Lewis and Clark Trail State Park (Mendel, G. and D.Karl 2000 Personal Communication). Winter and spring high flows carry large fine sediment loads derived from sheet and rill erosion of agricultural fields (USDA Soil Conservation Service *et al.* 1984). Severe erosion also takes place during intense summer and fall rain storms (Mendel, G. and D.Karl 2000 Personal Communication). These conditions combine to make the majority of the Lower Touchet unsuitable for salmonid spawning and rearing. Salmonid bearing streams in this subbasin include the Touchet River, Patit Creek, Whiskey Creek, and Coppei Creek. Steelhead and rainbow trout juveniles are present in the Touchet River to slightly downstream of Waitsburg. Bull trout adults may be present in the Touchet downstream to Waitsburg from November through May (Mendel, G. and D.Karl 2000 Personal Communication). See Map 11 and Map 12 in Appendix B.

Lower Touchet Subbasin Common Habitat Characteristics

Substrate Embeddedness

Fine sediment inputs are a serious problem in the lower Touchet Subbasin. Eighty-eight percent of the sediment delivered to streams in Southeast Washington was delivered by sheet and rill erosion of cropland. As of 1984, 580,700 tons/yr of fine sediment were delivered from cropland to streams in the Touchet Basin. Forestlands delivered 3,639 tons/yr. In 1981, 72% of nonirrigated cropland in the Touchet watershed had an erosion rate >5 tons/acre/yr (An erosion rate of 5 tons/acre/yr is the maximum sustainable erosion rate.) (USDA Soil Conservation Service *et al.* 1984). Substrate embeddedness becomes progressively worse as one moves downstream. See Figure 13 below.

Figure 13. Muddy Touchet River water at Cummins Road Bridge following an early October 2000 rainstorm.

Large Woody Debris

Large woody debris is lacking throughout the subbasin. Loss of access to floodplains through channelization and diking, clearing of riparian forests, and removal of wood from stream channels have all contributed to the relative absence of large wood in streams. Current habitat conditions are not favorable to future woody debris recruitment (TAG 2000 Personal Communication).

Water Quality/Temperature

Naturally low summer stream flows exacerbated by irrigation water withdrawals and destruction of riparian zones have led to water temperatures frequently exceeding 24°C (75°F) for extended periods (generally June 1 through October 1). These temperatures are far too warm for salmonids and are suspected of causing thermal barriers from the mouth of the Touchet River upstream to Lewis and Clark Trail State Park (Mendel *et al.* 1999). Fine sediment eroded from agricultural fields causes high total suspended solid (TSS) levels from December through June. The worst conditions normally occur in February (but may occur as early as October during high intensity rain events) with an average TSS level for 1978-1997 of 975 mg/L. The U.S. Fish and Wildlife service recommends maximum TSS levels of 80 mg/L to protect salmonids (Saul *et al.* 1999).

Water Quantity/Dewatering

Dewatering ranging from isolated pools to dry stream beds occasionally occurs during the summer months from Hofer Dam (RM 5.0) downstream to the mouth of the Touchet (Mendel *et al.* 1999). Insufficient flows are known to hinder steelhead migration (Mendel, G. and D.Karl 2000 Personal Communication). Hunter and Cropp (1975) calculated that 80 cfs (measured at USGS Bolles gage mainstem Touchet River) was the minimum flow needed to allow adequate adult anadromous fish passage on the Touchet River.

Biological Processes

Anadromous fish runs are depressed, yielding fewer carcasses and therefore lowering the productivity of streams in the Walla Walla River Basin (Mendel, G. 2000 Personal Communication). The beaver population in the Walla Walla Basin (and throughout Southeast Washington) was nearly exterminated by fur trappers by 1835. At the present time riparian vegetation in this subbasin likely could not support a thriving beaver population. In fact, reintroduction of beaver would likely damage *young* riparian vegetation incorporated in salmonid habitat restoration projects. The beaver population will likely grow once riparian forest buffers are reestablished.

Touchet River (Lewis and Clark Trail State Park to Coppei Creek, including tributaries)

Habitat Ratings

Fish Passage

U.S. Army Corps of Engineers (1997) identified one partial channel spanning barrier (likely gravel push-up dam) on this reach of the Touchet River. A dam at approximately RM 1.0 on Whiskey Creek has been identified as a probable barrier (Mendel, G. 2000 Personal Communication). Funding has been obtained to correct the problem on Whiskey Creek (TAG 2001 Personal Communication).

Screens and Diversions

Preliminary data from the WDFW CCRP identified one gravity diversion and eight pump diversions in use on the Touchet River. One pump diversion is known to be in use on Whiskey Creek (Bireley 2000).

Riparian Condition

Riparian zones in the Lower Touchet Subbasin are far different today than they were prior to European settlement. Accounts from the Lewis and Clark Expedition in 1805 and Dice (1916) describe extensive riparian buffers dominated by cottonwoods 80 to 100 feet in height and 3 to 4 feet in diameter. These forests featured a well developed understory of shrubs, grasses, and forbs (Mudd 1975). In many cases the shrub understory has been cleared out by livestock or man. In 1975 only 37% of the riparian zones in the Lower Touchet Subbasin fit the historic description above (Mudd 1975). A good example of the historic riparian plant community along the Touchet River can be viewed at Lewis and Clark Trail State Park at the top of this reach.

Streambank Condition

Reckendorf and Tice(2000) reported 85.8% of stream banks assessed along this reach as stable. However, banks along most of the reach are stabilized by dikes and bank armoring (Tice, B. 2001 Personal Communication).

Floodplain Connectivity

Flood control projects in and around populated areas have disconnected the Touchet River from over 50% of the historic 100-year floodplain (Federal Emergency Management Agency 1988, cited in Saul *et al.* 1999). The U.S. Army Corps of Engineers built extensive flood control levees in and around the city of Waitsburg following massive flood events in 1964 and 1996 (U.S. Army Corps of Engineers 1997). Numerous privately owned and maintained dikes are present along this reach, causing significant floodplain disconnections (TAG 2000 Personal Communication). Most floodplains have been denuded of natural riparian vegetation and are in agricultural production of wheat, peas, or alfalfa.

Width/Depth Ratio

No information is available on width/depth ratio.

Substrate Embeddedness

There is an abundance of loose gravel available for spawning, however sediment reduces salmonid use. Age 0+ rainbow have been observed hiding in spaces between cobbles on this reach (Karl, D. 2000 Personal Communication). See Lower Touchet Subbasin Common Habitat Characteristics.

Large Woody Debris

Large Woody Debris (LWD) is deficient on this reach as it is in nearly the entire Touchet River system (TAG 2000 Personal Communication). Reckendorf and Tice(2000) measured 9.4 pieces of LWD per mile. The scarcity of LWD is attributed to a lack of functional riparian zones, removal of LWD from the channel, and loss of floodplain connectivity.

Pool Frequency

Pools are not as common as desired to provide for salmonid habitat requirements (TAG 2000 Personal Communication).

Pool Quality

Lower quality pools with little cover are commonly found on the outside of channel meanders. Some pools large enough to be used as swimming holes are present near the Columbia/Walla Walla County line (Tice, B. 2001 Personal Communication). Reckendorf and Tice(2000) rated pool quality as fair. See RAPFAHRS in Appendix C.

Off-Channel Habitat

Agricultural activities including diking, filling of wetlands, conversion of riparian forest to cropland, and channelization have eliminated nearly all the off-channel habitat along this reach (TAG 2000 Personal Communication).

Water Quality/Temperature

Maximum water temperatures routinely exceeded 70°F during the summer of 1999 with averages ≥ 65°F from early July through late August (Mendel *et al.* 2000). Temperatures along this reach exceed the tolerance level of salmonids during mid July to mid September with spot daytime measurements ≥78°F. Water temperatures are suspected of causing a thermal barrier in the Touchet River from Lewis and Clark Trail State Park to the mouth (Mendel *et al.* 1999). Whiskey Creek maximum temperatures never exceeded 65°F during the summer of 1999, and average temperatures were <58°F (Mendel *et al.* 2000).

Water Quantity/Dewatering

Some salmonid rearing takes place on this reach. Naturally low summer flows worsened by irrigation withdrawals reduce habitat available for rearing (Mendel, G. and D.Karl 2000 Personal Communication). See Lower Touchet Subbasin Common Habitat Characteristics.

Change in Flow Regime

Irrigation withdrawals and floodplain development have altered the natural flow regime, but the extent of this change can not be measured because of a lack of presettlement flow data (TAG 2000 Personal Communication).

Biological Processes

Smallmouth bass, and brown trout are present in this reach. These exotic species compete with native salmonids for food and habitat and feed on juvenile salmonids (Mendel *et al.* 1999). The brown trout stocking program was discontinued in 1999 because of potential impacts on federally listed salmonids (Mendel *et al.* 2000). The population is naturally reproducing, but does not appear to be growing (Mendel, G. 2000 Personal Communication).

Touchet River (Coppei Creek to Hwy. 125 bridge, including tributaries)

Habitat Ratings

Fish Passage

No artificial obstructions were identified on this reach (TAG 2000 Personal Communication).

Screens and Diversions

Preliminary data from the WDFW CCRP identified two pump diversions in use on this reach of the Touchet River (Bireley 2000).

Riparian Condition

The riparian zone along this reach has been changed substantially from historic conditions, but it is still providing some function. Reckendorf and Tice(2000) describes the riparian zone as a narrow buffer with minimal mature trees, but providing some shade. See Figure 14 below.

Figure 14. Touchet River at Pettyjohn Road. The riparian vegetation in the photo is representative of the reach from Coppei Creek to Hwy. 125. Photo taken October 2000.

Streambank Condition

Reckendorf and Tice(2000) characterized 82% of banks assessed on this reach as stable. However, the relatively stable banks are the result of numerous dikes located throughout the reach. Livestock damage is also present in several areas (Tice, B. 2001 Personal Communication).

Floodplain Connectivity

The U.S. Army Corps of Engineers built extensive flood control levees in and around Waitsburg and Prescott following massive flood events in 1964 and 1996 (U.S. Army Corps of Engineers 1997). These flood control projects have disconnected the Touchet River from over 50% of the historic 100-year floodplain (Federal Emergency Management Agency, cited in Saul *et al.* 1999). Numerous privately owned and maintained dikes are present along this reach, causing significant floodplain disconnections (TAG 2000 Personal Communication). The stream channel downstream of Bolles Bridge has not been diked as extensively as the reaches near Prescott and Waitsburg (Tice, B. 2001 Personal Communication). Most floodplains have been denuded of natural riparian vegetation and are in agricultural production of wheat, peas, or alfalfa.

Width/Depth Ratio

No data on width/depth ratio was available.

Substrate Embeddedness

Several reaches near Prescott have very low gradients, yielding thick mud bottoms (Tice, B. 2001 Personal Communication). Substrate in this reach is embedded and characterized as "poor" (Mendel, G. and D.Karl 2000 Personal Communication). See Lower Touchet Subbasin Common Habitat Characteristics.

Large Woody Debris

Large woody debris (LWD) is not abundant on this reach, but some is present. Significant amounts of LWD were deposited by the 1996 and 1997 floods in the channel downstream from Bolles Bridge (Tice, B. 2001 Personal Communication). Reckendorf and Tice(2000) reported 20.8 pieces per mile along this reach.

Pool Frequency

Pools were fairly common on this reach. Reckendorf and Tice(2000) counted 23.3 pools per mile with an average wetted channel width of 20 to 30 feet. Pools are more common downstream of Bolles Bridge where the stream has not been confined between dikes and LWD is relatively common (Tice, B. 2001 Personal Communication).

Pool Quality

Pools downstream of Bolles Bridge are deep with good LWD cover. Unfortunately the substrate in this area is dominated by silt (Tice, B. 2001 Personal Communication). Reckendorf and Tice(2000) rated pool quality fair. See RAPFAHRS in Appendix C.

Off-Channel Habitat

Some off-channel habitat exists on this reach (TAG 2000 Personal Communication). Recent floods caused channel shifting that reconnected abandoned channels to the active channel. However, most of these backwater areas have little or no flow (Tice, B. 2001 Personal Communication).

Water Quality/Temperature

Maximum water temperatures frequently exceeded 70°F during the summers of 1998, 1999 and 2000. Average temperatures were >70°F from mid July through mid August (Mendel *et al.* 2000; Mendel and Karl 2000). See Lower Touchet Subbasin Common Habitat Characteristics.

Water Quantity/Dewatering

See Lower Touchet Subbasin Common Habitat Characteristics.

Change in Flow Regime

Irrigation withdrawals and floodplain development have altered the natural flow regime, but the extent of this change can not be measured because of a lack of presettlement flow data (TAG 2000 Personal Communication).

Biological Processes

Smallmouth bass, and brown trout are present in this reach. These fish were introduced. Bass and brown trout compete with native salmonids for food and habitat and they also feed on juvenile salmonids (Mendel *et al.* 1999). The brown trout stocking program was discontinued in 1999 because of potential impacts on federally listed salmonids (Mendel *et al.* 2000). The population is naturally reproducing, but does not appear to be growing (Mendel, G. 2000 Personal Communication).

Coppei Creek (including North and South Forks and tributaries)

Habitat Ratings

Fish Passage

A six foot high falls located at approximately RM 9.5 (between Coppei Road and the railroad bridge) may be a passage barrier during low flows (Reckendorf 1998). Steelhead spawning has been documented above this falls in recent years. A natural falls 40 to 50 feet high is present in the headwaters of the South Fork Coppei Creek (Tice, B. 2001 Personal Communication).

Screens and Diversions

Preliminary data from the WDFW CCRP identified four pump diversions in use on the Coppei Creek system (Bireley 2000).

Riparian Condition

Riparian condition ranges from highly degraded on the lower mainstem of Coppei Creek near Waitsburg to a mix of mature deciduous and coniferous trees in the headwaters. The riparian zone from McCowan Road downstream to Waitsburg is a very narrow buffer of immature trees, often growing in the stream channel. Much of this area is farmed to the stream edge. Riparian buffer restoration is needed on about 31,350 feet (37%) of the banks assessed from the Walker Road Bridge (approximately RM 8.0) downstream to the mouth (Reckendorf 1998). Over 5 miles of stream bank were enrolled in the Conservation Reserve Enhancement Program between 1998 and 2000 (Smith, L. 2000 Personal Communication). A large portion of the riparian zone on the South Fork Coppei Creek is intact with mature trees. Buffer width and species composition varies depending upon property ownership. A significant portion of this reach is now protected by a permanent easement brokered by the Tri-State Steelheaders, Walla Walla Conservation District and a local landowner. However, many areas of the Coppei Creek system are still open to cattle grazing (Tice, B. 2001 Personal Communication).

Streambank Condition

About 8,200 feet (10%) of streambanks assessed in 1998 were classified as eroding. These eroding banks provide a substantial coarse gravel load. About 50% of the eroding banks were comprised of fine sediment that smothers salmonid redds. Removal of riparian vegetation was identified as a cause of streambank erosion (Reckendorf 1998). The channel is deeply incised with numerous dikes and bank armoring from McCowan Road downstream (TAG 2001 Personal Communication).

Floodplain Connectivity

Extensive areas of riprap and armored dikes are found from RM 8.0 downstream. Many gravel dikes have been built here as well. Channel modifications including straightening, removal of gravel from the streambed, and construction of gravel dikes have caused reduced sinuosity (stream length) and channel incision. A large portion of the stream alterations occurred prior to 1969 (Reckendorf 1998). An alarming trend of housing development has been noted along in the narrow canyon of the upper portion of the South Fork Coppei Creek. An unimproved county road provides access to the area, but bridges are not present. Several fords are necessary to cross the creek (TAG 2000 Personal Communication). Coppei Creek provides some of the best habitat available to salmonids in the Lower Touchet Subbasin.

Width/Depth Ratio

No information on width/depth ratio is available.

Substrate Embeddedness

About 90% of the 37 square mile Coppei Creek Watershed is highly erodible dry cropland (Reckendorf 1998). Fine sediment inputs have caused severely embedded gravel in many areas from RM 8.0 downstream (TAG 2001 Personal Communication).

Large Woody Debris

Large woody debris was rare from RM 8.0 downstream (Reckendorf 1998). A significant amount of channel straightening and downcutting have occurred on this portion of stream. Logging in the upper watershed, lack of access to the floodplain and the straightened channel limit the stream’s ability to recruit and retain LWD (Tice, B. 2001 Personal Communication). In 1998 Walla Walla CD installed 46 pieces of LWD between McCowan Road and the forks (Smith, L. 2000 Personal Communication).

Pool Frequency

Riffles and glides are the most common habitat feature from RM 8.0 downstream. This reach should have an extensive pool/riffle morphology. Channel modifications including straightening, removal of gravel from the streambed, and construction of gravel dikes have caused reduced sinuosity (stream length), channel incision and destruction of pools and winter rearing habitat (Reckendorf 1998). The relative absence of LWD is likely another factor limiting pool formation.

Pool Quality

No information on pool quality is available.

Off-Channel Habitat

Stream modifications including dikes, riprap, and channel straightening have caused channel incision and floodplain disconnections from RM 8.0 downstream. These activities have eliminated off-channel habitat. About 600 feet of off-channel habitat could be developed by reconnecting old channels in the floodplain (Reckendorf 1998).

Water Quality/Temperature

Lower Coppei Creek is likely a thermal barrier during July and August (Mendel *et al.* 1999). Maximum water temperatures on Coppei Creek frequently exceeded 70°F during the summers of 1999 and 2000. Average temperatures were >65°F from early June through mid late August. Maximum water temperatures on the North and South Forks of Coppei Creek frequently exceeded 65°F during the summers of 1999 and 2000, but average temperatures rarely exceeded this value (Mendel *et al.* 2000; Mendel and Karl 2000). Homes are being built directly adjacent to the stream with septic systems that appear very likely to discharge effluent to the streams (TAG 2000 Personal Communication).

Water Quantity/Dewatering

Flows less than 3 cfs (just upstream of McCowan Road Bridge) were recorded from mid-June through September 1999 and 2000 (Mendel *et al.* 2000; Mendel and Karl 2000).

Change in Flow Regime

Surface water diversions have altered the flow regime, but it is impossible to determine the extent of the change because no flow data exists prior to irrigation (TAG 2000 Personal Communication).

Biological Processes

See Lower Touchet Subbasin Common Habitat Characteristics.

Touchet River (Hwy. 125 bridge to Walla Walla River, including tributaries)

Habitat Ratings

Fish Passage

Hofer Dam (RM 5.0) is a passage barrier at low flows. The entire flow of the Touchet River is diverted at this dam, leaving the channel downstream a series of mostly stagnant or isolated pools during the summer months (Mendel *et al.* 1999; Saul *et al.* 1999). A boulder push-up dam downstream from Hofer Dam is also full channel spanning barrier (TAG 2001 Personal Communication).

Screens and Diversions

Preliminary data from the WDFW CCRP identified three gravity diversions and 30 pump diversions in use on this reach of the Touchet River (Bireley 2000).

Riparian Condition

Trees are a rare sight in the riparian zone of this reach, especially mature trees. Where present they occur in a very fragmented distribution of one or two trees per patch. Much of the reach can be viewed by driving along Touchet North Road and State Highway 124. See Figure 15 below.

Figure 15. Touchet River at Lamar. The riparian vegetation in this photo is representative of the condition from Hwy. 125 to the mouth. Photo taken October 2000.

Streambank Condition

No information is available on streambank condition.

Floodplain Connectivity

Most floodplains have been denuded of natural riparian vegetation and are in agricultural production of wheat, peas, or alfalfa. The river has access to the floodplain, but the lack of vegetation likely reduces the water holding capacity of the groundwater table.

Width/Depth Ratio

No data was available on width/depth ratio.

Substrate Embeddedness

A large portion of this reach is characterized by a mud bottom. Gravel (if present) is not just embedded, but buried by mud (Mendel, G. and D.Karl 2000 Personal Communication). See Lower Touchet Subbasin Common Habitat Characteristics.

Large Woody Debris

Removal of wood from the channel during flood control work and a lack of functional riparian zones have combined to limit the amount of LWD present in this reach (TAG 2000 Personal Communication).

Pool Frequency

No quantitative data on pool frequency are available, but because of the low gradient pools are believed to be common (TAG 2001 Personal Communication).

Pool Quality

Large deep pools are relatively common on this reach. However, pools lack instream and overhead cover (TAG 2000 Personal Communication).

Off-Channel Habitat

Agricultural activities including filling of wetlands, conversion of riparian forest to cropland, channelization, and diking have eliminated nearly all off-channel habitat along this reach (TAG 2000 Personal Communication).

Water Quality/Temperature

Summer water temperatures on this reach are far above the requirements of salmonids. Hunter and T.D.Cropp (1975) measured July and August temperatures >80°F. Mean temperatures greater than 75°F for extended periods, spot daytime measurements ≥78°F, and an absence of salmonids during fish population surveys were all described by Mendel *et al.* (1999). Water temperatures were again extremely warm in the summers of 1999 and 2000 with maximum values frequently exceeding 80°F and average values exceeding 75°F from mid July through late August (Mendel *et al.* 2000; Mendel and Karl 2000). See Lower Touchet Subbasin Common Habitat Characteristics.

Water Quantity/Dewatering

Flows are inadequate to allow salmonid passage from Hofer Dam (RM 5.0) downstream to the mouth during the summer and early fall months. This reach is often reduced to a series of isolated pools as the majority of water is diverted from the mainstem Touchet at Hofer Dam to agricultural fields (Mendel *et al.* 1999; Saul *et al.* 1999). See Figure 16 below.


Figure 16. Touchet River at Cummins Road during the summer of 2000.

Change in Flow Regime

Surface water withdrawals have substantially lowered summer base flows (Mendel *et al.* 1999, TAG 2000 Personal Communication). Flows below Hofer Dam are reduced to levels that create passage problems for migrating steelhead (Mendel, G. and D.Karl 2000 Personal Communication).

Biological Processes

Smallmouth bass, carp, and catfish are present in this reach. All these fish were introduced. The bass compete with native salmonids for food and habitat and also feed on juvenile salmonids (Mendel *et al.* 1999). See Lower Touchet Subbasin Common Habitat Characteristics.

LOWER TOUCHET SUBBASIN RECOMMENDATIONS

1. Restore instream flows, particularly below Hofer Dam.
2. Conduct a comprehensive inventory of surface water diversions and ensure compliance with juvenile fish screening regulations.
3. Restore floodplain connectivity and natural channel migration where practical in agricultural areas through removal of dikes or conversion to set back dikes.
4. Restore riparian forests, attempting to reestablish connectivity between existing patches of riparian forest and restoration project areas.
5. Restrict installation of instream habitat projects to spawning and rearing areas such as Coppei Creek.
6. Maximize restoration and/or protection of salmonid spawning and rearing habitat in Coppei Creek. Protect the existing high quality riparian and instream habitat along the South Fork Coppei Creek.
7. Reduce fine sediment inputs to streams by replacing conventional tillage of dry cropland with no-till farming methods and decommissioning dirt roads.
8. Gather additional water quality data (not just temperatures).
9. Enforce land use regulations including the Growth Management Act, Shoreline Management Act, and Critical Area Ordinances.

LOWER WALLA WALLA SUBBASIN HABITAT LIMITING FACTORS

Lower Walla Walla Subbasin Description

The Lower Walla Walla Subbasin is defined as the mainstem Walla Walla River below the stateline and all tributaries flowing into this portion of the river not identified in separate subbasins. See Map 4 in Appendix B. Population centers include Walla Walla/College Place (population approx. 35,000), Lowden (population approx. 50), Touchet (population approx. 410), and Dixie (population approx. 200) (U.S. Army Corps of Engineers 1997). The North and South Forks of Dry Creek and Cottonwood Creek originate in the Blue Mountains. Pine Creek, and Mud Creek (Walla Walla River tributary) originate in gently rolling Palouse hills in Oregon. Mill Creek originates high in the Blue Mountains, while Yellowhawk and Garrison creeks are distributaries of Mill Creek *(a distributary is a stream channel that carries water away from the mainstem rather than carrying water toward the mainstem in the case of a tributary)*. These two streams are now controlled by U.S. Army Corps of Engineers headgates and used to convey water from Mill Creek to the Walla Walla River via Yellowhawk and Garrison Creeks. Prior to the Corps project both streams were naturally connected to Mill Creek (1928, Newcomb 1965). The headgates were installed to control distribution of irrigation water throughout the system (Neve, W. 2000 Personal Communication).

Land use ranges from highly urbanized in the Walla Walla/College Place vicinity to agriculture throughout the remainder of the subbasin. Wheat and peas are the primary dryland crops cultivated in the uplands. Onions, apples, cherries, grapes, asparagus, strawberries, and alfalfa are grown on the irrigated valley bottoms. Riparian zones along these streams were historically dense stands of deciduous trees and shrubs dominated by cottonwoods and willows. Springs and small meadows teaming with forbs and wildflowers were commonly interspersed within the riparian community (Lewis and W.Clark 1893; Mudd 1975; Saul *et al.* 2000).

Today water is used primarily for human consumption including irrigation of crops and lawns, cleaning sidewalks and automobiles, and landscaping such as ornamental ponds. Destruction of riparian zones, misuse of springs and artesian wells, and low summer stream flows exacerbated by surface water withdrawals have combined to create high water temperatures throughout this subbasin (Confederated Tribes of the Umatilla Indian Reservation *et al.* 1990; U.S. Army Corps of Engineers 1997; Mendel *et al.* 1999; Mendel *et al.* 2000). High inputs of fine sediment originating from sheet and rill erosion of croplands are also a significant problem (USDA Soil Conservation Service *et al.* 1984, Saul *et al.* 2000; Confederated Tribes of the Umatilla Indian Reservation *et al.* 1990). Eighty-eight percent of the sediment delivered to streams in Southeast Washington (south of the Snake River) was delivered by sheet and rill erosion of cropland (USDA Soil Conservation Service *et al.* 1984). Large woody debris (LWD) is deficient throughout the subbasin. Many stream reaches have been altered by diking and/or channelization (U.S. Army Corps of Engineers 1997). Beaver were historically present in large numbers throughout Southeast Washington (Lewis and W.Clark 1893; Meinig 1968; Saul *et al.* 2000), but were nearly exterminated by fur trappers by 1835 (Meinig 1968). The absence of thriving beaver populations in the Walla Walla Basin is being evidenced today by a lack of off-channel habitat, few wetlands, and stream flow regimes with high winter peaks and low summer flows (and associated high temperatures). Beaver are a significant link missing from the ecosystem in the Walla Walla Basin (Saul *et al.* 2000).

Summer steelhead (also includes resident rainbow/redband trout) are found throughout the subbasin in the mainstem Walla Walla River, Mill Creek, Yellowhawk Creek, Dry Creek, Mud Creek (Dry Creek tributary), Cottonwood Creek, Pine Creek, Cold Creek, Doan Creek, Garrison Creek, Stone Creek, Caldwell Creek, Reser Creek, Russell Creek, East and West Little Walla Walla River, and presumed to be present in Mud Creek (Walla Walla tributary). Bull trout juveniles have been observed in a portion of Mill Creek within the City of Walla Walla and the Walla Walla River possibly downstream as far as McDonald Bridge Road (Mendel, G. and D.Karl 2000 Personal Communication). This bull trout usage is suspected to be confined to winter rearing when water temperatures are cool enough for these temperature sensitive fish. A large fluvial adult bull trout was observed migrating upstream in the Walla Walla River near McDonald Road in the spring of 2000 (Mendel, G. 2000 Personal Communication; Grandstaff, M. 2000 Personal Communication). Spring Chinook were historically present in the basin, but were extirpated between the 1930's and 1950's (Nielson 1950, Mendel, G. 2000 Personal Communication). A pair of fall chinook were seen spawning in Mill Creek downstream from Swegle Road in the fall of 2000 and a few spring chinook have been observed each year since the mid 1990s (Mendel, G. 2000 Personal Communication). See Map 11 and Map 12 in Appendix B.

Lower Walla Walla Subbasin Common Habitat Characteristics

Fish Passage

Numerous gravel push-up dams are utilized along this portion of the Walla Walla River. These structures are usually washed out annually during high winter flows, forcing reconstruction on a yearly basis. The structures represent partial barriers during low summer flow conditions. Surface water diversions that are improperly screened or not screened at all are a significant passage problem for juvenile salmonids in the Washington portion of the watershed. See Landuse and Salmonid Habitat Conditions.

Riparian Condition

Riparian zones along this portion of the Walla Walla River have generally been significantly altered from presettlement conditions. The riparian zones present today are much narrower (often one tree in width) and often found in a patch-work distribution. Though the extent of the riparian zone has been reduced, species composition seems close to the natural condition with the exception of the introduction of black locust trees and reed canary grass. The riparian plant community from the stateline to approximately the mouth of the Touchet River is dominated by cottonwood, alder, and willows. From the Touchet River down to the mouth of the Walla Walla River the riparian plant community becomes shrub dominated. This closely matches accounts from the Lewis and Clark Expedition of 1806 which made particular note of encountering large quantities of timber at the mouth of the Touchet River. Prior to this point on their return journey up the Walla Walla River they had great difficulty gathering firewood (Lewis and W.Clark 1893).

Substrate Embeddedness

Fine sediment inputs into the Walla Walla River below the town of Lowden are very high. The river bed is comprised of highly embedded gravel and angular rock from this point to the mouth (Mendel, G. 2000 Personal Communication, Tice, B. 2001 Personal Communication). Dry Creek and the Touchet River carry some of the highest sediment loads in the United States (Confederated Tribes of the Umatilla Indian Reservation *et al.* 1990). As of 1984, 73,800 (tons/yr) fine sediment were delivered from cropland to streams in the Walla Walla Basin *(not including Dry Creek and Touchet River inputs*). For comparison, forestlands delivered 613 (tons/yr). In 1981 53% of nonirrigated cropland in the Walla Walla Basin had an erosion rate >5 tons/acre/yr (the maximum soil erosion rate allowable to maintain sustainable agricultural production) (USDA Soil Conservation Service *et al.* 1984).

Large Woody Debris

Large woody debris is lacking throughout the Washington portion of the Walla Walla River (a trait common to the majority of streams in the WRIA). Loss of access to floodplains through channelization and diking, clearing of riparian forests, and removal of wood from stream channels to speed passage of flood waters have all contributed to the relative absence of large wood in streams. Current habitat conditions are not favorable to future woody debris recruitment (TAG 2000 Personal Communication).

Water Quality/Temperature

Naturally low summer stream flows exacerbated by irrigation water withdrawals and destruction of riparian zones have led to water temperatures frequently exceeding 24°C (75°F) for extended periods (generally July through September). These temperatures are far too warm for salmonids and are suspected of causing thermal barriers throughout the Washington portion of the Walla Walla River (Mendel *et al.* 1999). Fine sediment inputs from sheet and rill erosion of cropland are a serious problem throughout the Lower Walla Walla Subbasin (USDA Soil Conservation Service *et al.* 1984).

Water Quantity/Dewatering

Dewatering ranging from isolated pools to dry stream beds occurs from the stateline to the mouth of the Walla Walla River (U.S. Army Corps of Engineers 1997), although dry streambeds have not been documented in a recent study (Mendel *et al.* 1999 and 2000). Under terms of an agreement signed by Walla Walla Basin irrigation districts and the U.S. Fish and Wildlife Service in the year 2000, 13 cubic feet per second (cfs) and 10 cfs of flow were required to be left in the river at Milton-Freewater, Oregon and Burlingame Diversion, Washington respectively. In the past the river was “dried up” at both of these diversions. The additional water at Milton-Freewater did little to improve conditions in the reach near the stateline, but appears to have improved flows farther downstream. Work is needed to identify where this water comes back to the surface (Neve, W. 2000 Personal Communication). In the past about 2 miles of river below Milton-Freewater went dry, but the required flows reduced this to about ¼ mile according to the Oregon Water Resources Department, who took stream flow measurements along this reach the entire summer (Neve, W. 2000 Personal Communication). The "newly watered" section contained a small amount of surface water, but little volume or flow were present (Neve, W. 2000 Personal Communication). The dewatering problem has resulted in several cooperative fish salvage operations on the reach from Milton-Freewater to the stateline. See Walla Walla River Fish Rescue for further details.

Change in Flow Regime

Though changes in the flow regime have undoubtedly occurred, they would be difficult to quantify without baseline data collected prior to large scale irrigation water withdrawals. Irrigation in the Walla Walla Basin began in 1860 at the Whitman Mission and was widespread by about 1880, but the earliest flow data (1914 and later) were collected following many years of irrigation withdrawals (Saul *et al.* 2000). Because of this, development of a presettlement hydrograph would be pure speculation. Although 25 USGS gages were present in the Walla Walla Basin, only three are currently in use (U.S. Army Corps of Engineers 1997).

Biological Processes

Anadromous fish runs are depressed, yielding fewer carcasses and therefore lowering the productivity of streams in the Walla Walla River Basin (Mendel, G. 2000 Personal Communication). The beaver population in the Walla Walla Basin (and throughout Southeast Washington) was nearly exterminated by fur trappers by 1835 (Meinig 1968). Although some beaver are present, the population is not large enough to create or maintain the salmonid habitat that was likely historically present in the Walla Walla Basin (Saul *et al.* 2000).

Walla Walla River (Stateline to Mill Creek, including East and West Little Walla Walla Rivers)

Habitat Ratings

Fish passage

Irrigation diversion dams are the predominant fish passage barriers on this reach. At least four diversion dams are present along this section of the Walla Walla River (U.S. Army Corps of Engineers 1997). Burlingame Diversion has an adequate fish ladder and new modern screens (TAG 2000 Personal Communication). A new fish screen has been installed on the Smith/Nelson diversion (about 1 mile downstream from Burlingame Diversion) and a project is underway to replace the gravel push-up dam (Neve, W. 2000 Personal Communication).

Screens and Diversions

Preliminary data from the WDFW CCRP identified two gravity diversions and 12 pump diversions in use on this reach of the Walla Walla River. A minimum of 12 diversions (10 pump and 2 gravity) are thought to be in use on the East and West Little Walla Walla River. On the "Spring Branch," a tributary of the Little Walla Walla River, 27 pump and 6 gravity diversions are thought to be in use. Stone Creek (small RB tributary upstream from Garrison Creek) has 17 pump and 2 gravity diversions thought to be in use (Bireley

2000). The gravity diversions are both screened (Neve, W. 2000 Personal Communication).

Riparian Condition

Riparian zones along this reach are composed of some trees and shrubs providing some shade, but buffers are marginal and not nearly as wide or contiguous as they were historically (TAG 2000 Personal Communication).

Streambank Condition

Banks from the stateline downstream to Pepper Bridge are very unstable (Mendel, G. and D.Karl 2000 Personal Communication). Areas of stable banks are largely attributed to dikes along the reach (TAG 2000 Personal Communication).

Floodplain Connectivity

Many dikes and roads along this reach restrict channel migration and limit floodplain connectivity (Mendel, G. and D.Karl 2000 Personal Communication).

Width/Depth Ratio

Data on width/depth ratio were not available.

Substrate Embeddedness

Substrate is moderately to highly embedded throughout this reach and worsens progressively as one moves downstream (Mendel, G. and D.Karl 2000 Personal Communication).

Large Woody Debris

Large woody debris (LWD) is generally lacking on this reach (TAG 2000 Personal Communication).

Pool Frequency

No data on pool frequency are available.

Pool Quality

No data on pool quality are available.

Off-Channel Habitat

Very little off-channel habitat is present on this reach (Mendel, G. and D.Karl 2000 Personal Communication). The lack of off-channel areas is attributed to numerous dikes (TAG 2000 Personal Communication).

Water Quality/Temperature

Water temperatures from approximately July through mid September create suboptimal conditions for salmonids with temperatures frequently exceeding 24°C (75°F) for extended periods (Mendel *et al.* 1999). Water temperatures were warm in the summers of 1999 and 2000 as well. Maximum temperatures frequently exceeded 70°F with average values > 65°F from early July through early September (Mendel *et al.* 2000;

Mendel and Karl 2000). See Lower Walla Walla Subbasin Common Habitat Characteristics for information on sediment loads.

Water Quantity/Dewatering

Flows along this reach from mid May through October are often not sufficient to support salmonid rearing or migration (Confederated Tribes of the Umatilla Indian Reservation *et al.* 1990; U.S. Army Corps of Engineers 1997; Mendel *et al.* 1999, TAG 2000 Personal Communication). See Lower Walla Walla Subbasin Description and Lower Walla Walla Subbasin Common Habitat Characteristics for more specific information. There was no apparent improvement in flow or water temperatures on this reach as a result of the additional water left in stream on the reach from Milton-Freewater to the stateline (Mendel, G. 2000 Personal Communication).

Change in Flow Regime

Since 1880 the entire flow of the Walla Walla River was diverted at Nursery Bridge (in Milton-Freewater, Oregon) into the Little Walla Walla River system (Nielson 1950). The same practice took place at Burlingame Dam (just downstream of the mouth of Yellowhawk Creek). This occurred until the 2000 irrigation season at which time the USFWS required that 13 cfs be passed downstream at Nursery Bridge and 10 cfs be passed downstream at Burlingame Dam (Durfee, S. 2000 Personal Communication). Gravel mining and channel straightening on both sides of the stateline is suspected to have lowered the river bed and thus the water table, exacerbating already low summer flows (Neve, W. 2000 Personal Communication).

Biological Processes

See Lower Walla Walla Subbasin Common Habitat Characteristics

Walla Walla River (Mill Creek to McDonald Road)

Habitat Ratings

Fish Passage

U.S. Army Corps of Engineers (1997) identified four partial channel spanning gravel push-up dams on this reach. Two of these diversions, Lowden No. 2 and Garden City are in the final stages of design work to install one permanent structure that will eliminate the need for gravel push-up dams (Neve, W. 2000 Personal Communication).

Screens and Diversions

There are at least 22 individual pump stations and 3 gravity diversions along this reach. Lowden No. 2 and Garden City diversions are also scheduled for replacement of gravel push-up dams with permanent structures as well as installation of screens that meet NMFS criteria (Neve, W. 2000 Personal Communication). Bergevin-Williams Diversion is a gravity diversion located on the right bank of the Walla Walla River at RM 31.6. Water flows 1500’ down a canal before entering a drum screen. This screen does not meet juvenile fish screening criteria. The mesh is too large and the surface area is too small. A 1600’ long juvenile fish bypass has a 3’ drop at the entrance. The bypass outlets into a side channel of the river (Montgomery Watson 1999).

Riparian Condition

Riparian vegetation along this reach is composed of a diverse mix of deciduous trees including cottonwood, alder, birch, and willows. The buffer varies in width depending upon land ownership, but is generally narrow (Kuttel 2001). See Figure 17 below.

Figure 17. Walla Walla River above Last Chance Road. Photo taken in early February 2001.

Streambank Condition

Reckendorf and Tice(2000) reported 94.9% of banks assessed (on a small reach upstream from McDonald Bridge) were stable. However, bank stability is the result of numerous streambank protection projects and channel modifications (TAG 2001 Personal Communication).

Floodplain Connectivity

Bank protection projects and channel modifications limit floodplain connectivity (TAG 2001 Personal Communication).

Width/Depth Ratio

No information on width/depth ratio is available.

Substrate Embeddedness

Substrate along this reach is moderately embedded (Mendel, G. and D.Karl 2000 Personal Communication).

Large Woody Debris

Large Woody Debris (LWD) is present on this reach, but not in sufficient quantities (TAG 2000 Personal Communication).

Pool Frequency

Reckendorf and Tice (2000) counted 11.6 pools per mile on a small portion of the lower end of the reach.

Pool Quality

Reckendorf and Tice(2000) rated pool quality as fair. This assessment may be biased since it took place along a reach were several rock and LWD structures had been installed in the stream to enhance salmonid habitat (Tice, B. 2001 Personal Communication). See RAPFAHRS in Appendix C.

Off-Channel Habitat

Disrupted floodplain access makes off-channel areas rare or nonexistent (TAG 2001 Personal Communication).

Water Quality/Temperature

High water temperatures cause suboptimal conditions for salmonids from Burlingame Diversion downstream to Swegle Road with mean temperatures >75°F for extended periods in 1998 (Mendel *et al.* 1999). Water temperatures continued to be extremely warm during the summers of 1999 and 2000. Maximum temperatures frequently exceeded 75°F and average temperatures exceeded 70°F from late June through mid August (Mendel *et al.* 2000; Mendel and Karl 2000). See Lower Walla Walla Subbasin Common Habitat Characteristics for information on sediment loads.

Water Quantity/Dewatering

See Lower Walla Walla Subbasin Common Habitat Characteristics for information on irrigation withdrawals upstream from this reach. The additional water left instream during the 2000 irrigation season (13 cfs at Nursery Bridge Diversion and 10 cfs at Burlingame Diversion) appears to have improved flows on this reach (Neve, W. 2000 Personal Communication), although similar improvement was not noticeable upstream (Mendel, G. 2000 Personal Communication).

Change in Flow Regime

See Lower Walla Walla Subbasin Common Habitat Characteristics for changes in the flow regime that impact several reaches of the Walla Walla River in Washington.

Biological Processes

See Lower Walla Walla Subbasin Common Habitat Characteristics for biological processes shared by all reaches of the Walla Walla River in Washington. In addition to the factors mentioned above a number of exotic fish species have been introduced to this reach of the Walla Walla River. These species include: smallmouth bass *(Micropterus dolomieui)*, carp *(Cyprinus carpio)*, and channel catfish *(Ictalurus punctatus)* (Mendel *et al.* 2000).

Walla Walla River (McDonald Road to Mouth)

Habitat Ratings

Fish Passage

One blocking gravel push-up dam, one gravity diversion, and numerous pumps are known to be present along this reach (TAG 2000 Personal Communication).

Screens and Diversions

One gravity diversion, Old Lowden Diversion, is located on the right bank of the Walla Walla River at RM 29.1. A 3' wide headgate controls the flow of water through a levee to a farm ditch. The diversion is screened, but out of compliance. The mesh size is too large and the screen surface area is too small. The existing juvenile bypass is unoperational (Montgomery Watson 1999). Preliminary data from the WDFW CCRP identified 30 pump diversions in use on this reach of the Walla Walla River (Bireley 2000).

Riparian Condition

Reckendorf and Tice(2000) characterized the riparian zone along this reach as a narrow buffer with minimal mature trees, but providing some shade. Although riparian buffers are narrow the shrub dominated species composition likely closely resembles the natural condition for this reach. Lewis and Clark passed through this area in April of 1806. They made particular mention of the Touchet River as "possess[ing] 20 times as much timber as the Columbia itself (Lewis and W.Clark 1893)." This suggests that large trees were an infrequent occurrence on the Walla Walla River from the mouth of the Touchet downstream. Walla Walla Conservation District has implemented a substantial Conservation Reserve Enhancement Program (CREP) buffer at Nine Mile Ranch (approximately RM 9).

Streambank Condition

Reckendorf and Tice(2000) reported 14% of banks actively eroding. Many vertical banks are present above the mouth of the Touchet River (TAG 2000 Personal Communication). The channel is downcut several feet in many areas. A new floodplain is being established within the incised channel (Tice, B. 2001 Personal Communication).

Floodplain Connectivity

Vertical banks above the Touchet River limit floodplain access (TAG 2000 Personal Communication). Channel incision has caused abandonment of the historic floodplain; it is now a terrace. A new floodplain is forming within the incised channel as the vertical banks cave in (Tice, B. 2001 Personal Communication).

Width/Depth Ratio

Portions of this reach are deeply incised yielding a relatively narrow, deep channel (TAG 2001 Personal Communication).

Substrate Embeddedness

The substrate along this reach from the town of Lowden downstream is highly embedded (TAG 2000 Personal Communication). Not coincidentally Dry Creek (252,0000 tons/yr) and the Touchet River (580,700 tons/yr) carry the highest sediment loads in the Walla Walla Basin (USDA Soil Conservation Service *et al.* 1984). The massive fine sediment loads and pooling of the Columbia River behind McNary Dam have contributed to formation of a large delta at the mouth of the Walla Walla River (Bureau of Reclamation 1997).

Large Woody Debris

Large woody debris (LWD) is present along this reach, but not in sufficient quantities (TAG 2000 Personal Communication).

Pool Frequency

Reckendorf and Tice(2000) counted 20.7 pools per mile with an average wetted channel width of 20 to 30 feet. Portions of this reach have high sinuosity which has allowed formation of large pools at outside meander bends.

Pool Quality

Pools on this reach have little instream or overhanging riparian vegetative cover. Many of the pools in sinuous reaches have mud bottoms (Tice, B. 2001 Personal Communication). Reckendorf and Tice(2000) reported pool quality was poor. See RAPFAHRS in Appendix C.

Off-Channel Habitat

Some off-channel habitat is present along this reach (TAG 2000 Personal Communication). Quantitative data are not available.

Water Quality/Temperature

Fine sediment inputs from sheet and rill erosion of cropland are a serious problem throughout the Lower Walla Walla Subbasin (USDA Soil Conservation Service *et al.* 1984). Water temperatures from approximately July through mid September create a probable thermal barrier to salmonids on this reach with temperatures frequently >75°F for extended periods, spot daytime measurements ≥78°F, and salmonids absent in fish surveys (Mendel *et al.* 1999). Temperatures were once again warm in the summer of 1999 with 74 consecutive days with maximum temperatures >70°F. Mean temperatures exceeded 70°F from mid June through late August (Mendel and Karl 2000). Three reaches from approximately river mile (RM) 13.0 downstream to the mouth were listed on the 1998 Environmental Protection Agency (EPA) 303(d) list for water pollution problems including: pesticides, ammonia, pH, low dissolved oxygen, high temperature, and other violations (Washington Department of Ecology 2000a).

Water Quantity/Dewatering

Flows along this reach from mid May through October are often not sufficient to support salmonid rearing or migration (Confederated Tribes of the Umatilla Indian Reservation *et al.* 1990; U.S. Army Corps of Engineers 1997; Mendel *et al.* 1999, TAG 2000 Personal

Communication). See Lower Walla Walla Subbasin Description and Lower Walla Walla Subbasin Common Habitat Characteristics for more specific information.

Change in Flow Regime

See Lower Walla Walla Subbasin Common Habitat Characteristics for flow regime changes shared by several reaches of the Walla Walla River in Washington.

Biological Processes

See Lower Walla Walla Subbasin Common Habitat Characteristics for biological processes shared by all reaches of the Walla Walla River in Washington. In addition to the factors mentioned above a number of exotic fish species have been introduced to this reach of the Walla Walla River. These species include: largemouth bass *(Micropterus salmoides)*, smallmouth bass *(Micropterus dolomieui)*, carp *(Cyprinus carpio)*, channel catfish *(Ictalurus punctatus)*, tadpole madtom *(Noturus gyrinus)*, and brown and black bullheads *(Ictalurus nebulosus and Ictalurus melas respectively)* (Mendel, G. 2000 Personal Communication).

Pine and Mud Creeks (Stateline to mouth)

Habitat Ratings

Fish Passage

No barriers have been identified on the Washington portion of Pine Creek (TAG 2000 Personal Communication). However, a grade control structure at approximately RM 7.0 in Oregon is a substantial barrier. See Figure 18 below. Abandoned check dams and other structures are suspected to be prevalent throughout these streams (TAG 2001 Personal Communication).

Figure 18. Grade control structure below Hudson's Bay Road on Pine Creek (Oregon). Photo taken fall of 2000.

Screens and Diversions

Preliminary data from the WDFW CCRP identified 8 pump diversions in use on Pine Creek in addition to 11 pump and 3 gravity diversions on Mud Creek (Bireley 2000).

Riparian Condition

Little or no riparian vegetation is present along this reach of Pine Creek as a result of farming to the edge of the streambank (Neve, W. 2000 Personal Communication).

Streambank Condition

Pine Creek is deeply incised to RM 7.0 (Oregon). This incision is the result of unstable banks caused by conversion of native riparian buffers to crop land. Stream banks frequently cave in forming temporary silt dams (Bureau of Reclamation 1997).

Floodplain Connectivity

Channel incision limits floodplain connectivity (Bureau of Reclamation 1997). See Figure 19 below.

Figure 19. Pine Creek upstream from Stateline Road. Photo taken fall of 2000.

Width/Depth Ratio

No data on width/depth ratio are available, but incision likely prevents formation of wide and shallow channels.

Substrate Embeddedness

Highly unstable streambanks caused by removal of riparian vegetation and channel incision contribute to a large fine sediment load. Substrate embeddedness is a problem on both streams (Tice, B. 2000 Personal Communication).

Large Woody Debris

No data on LWD are available, but the lack of riparian vegetation and channel incision likely make LWD rare.

Pool Frequency

No data on pool frequency are available, but the incised channel conditions likely lead to relatively high numbers of pools (TAG 2001 Personal Communication).

Pool Quality

No data on pool quality are available.

Off-Channel Habitat

No data on off-channel habitat is available, but channel incision and conversion of floodplains to cropland suggest that off-channel habitat would be rare.

Water Quality/Temperature

Maximum water temperatures on Pine and Mud Creeks routinely exceeded 80°F (26.7°C) during July and August in the summers of 1998, 1999, and 2000. Average temperatures commonly exceeded 70°F from late July through late August (Mendel *et al.* 2000; Mendel *et al.* 2000; Tice 2000). See Lower Walla Walla Subbasin Common Habitat Characteristics for sediment information.

Water Quantity/Dewatering

Irrigation withdrawals in October and November periodically dewater Pine Creek. Flows are highly dependant upon irrigation activities upstream in Oregon (Neve, W. 2000 Personal Communication).

Change in Flow Regime

The natural flow regime has been altered, but no data are available to assess the magnitude of the changes. See "Water Quantity/Dewatering" above.

Biological Processes

See Lower Walla Walla Subbasin Common Habitat Characteristics for biological processes shared by many streams in the Walla Walla Basin. Exotic fish species are suspected to be present in these streams (TAG 2001 Personal Communication).

Dry Creek (Headwaters to Hwy. 12 bridge near Smith Road)

Habitat Ratings

Fish Passage

A severe passage barrier is present on Mud Creek (right bank tributary at RM 28.8, East of the town of Dixie) at a failed culvert under an abandoned rail line (Mendel *et al.* 2000). About 2 miles (possibly more) of potential summer steelhead spawning and rearing habitat are upstream of this blockage. A large beaver dam is present downstream of the town of Dixie. The county road along the North Fork of Dry Creek has seven fords across the stream (TAG 2000 Personal Communication).

Screens and Diversions

Preliminary data from the WDFW CCRP identified four pump diversions in use on this reach (Bireley 2000).

Riparian Condition

The riparian zone a few miles above the town of Dixie is characterized by a relatively dense forest. From Dixie downstream the buffer becomes a thin strip often only one tree in width. A substantial portion of this thin buffer is comprised of non-native black locust trees. A wide riparian buffer is present above the barrier on Mud Creek (TAG 2000 Personal Communication).

Streambank Condition

Reckendorf and Tice(2000) observed erosion on 9% of banks assessed. Most erosion was associated with bridges. The channel has been straightened downstream of Dixie (Tice, B. 2001 Personal Communication).

Floodplain Connectivity

The upper portion of Dry Creek is a narrow canyon with a narrow floodplain. This area is rapidly being converted to home sites. Floodplain connectivity is good at this time, but the development taking place in the upper canyon will likely cause a problem with floodplain connectivity in the future (TAG 2000 Personal Communication). Channel incision becomes more common and increases in severity as one moves downstream (Tice, B. 2001 Personal Communication).

Width/Depth Ratio

No data on width/depth ratio are available.

Substrate Embeddedness

As of 1984, 252,000 tons/yr fine sediment were delivered from cropland to streams in the Dry Creek Basin. For comparison, forestlands delivered 354 tons/yr. In 1981, 75% of nonirrigated cropland in the Dry Creek watershed had an erosion rate >5 tons/acre/yr (the maximum soil erosion rate allowable to maintain sustainable agricultural production). (USDA Soil Conservation Service *et al.* 1984). Sedimentation rates this high suggest a problem with substrate embeddedness, but no data exists.

Large Woody Debris

Reckendorf and Tice(2000) reported 9.9 pieces of large woody debris (LWD) per mile.

Pool Frequency

Reckendorf and Tice(2000) counted 39.1 pools per mile with an average wetted channel width of 5 to 10 feet.

Pool Quality

Pools generally range from 1 to 1.5' deep. Although LWD is lacking, some undercut banks provide pools with cover (Tice, B. 2001 Personal Communication). Reckendorf and Tice(2000) reported pool quality was fair. See RAPFAHRS in Appendix C.

Off-Channel Habitat

No information on off-channel habitat is available.

Water Quality/Temperature

The North Fork of Dry Creek has relatively cool summer water temperatures. In the summers of 1999 and 2000, maximum values frequently exceeded 65°F. Average values never exceeded 62.5°F. Temperatures on the Dry Creek mainstem are not as favorable. Maximum temperatures frequently exceeded 70°F and averaged ≥65°F from mid July through mid August of 1999 and 2000 (Mendel *et al.* 2000; Mendel and Karl 2000).

Water Quantity/Dewatering

Dry Creek gets very low in the summer months. It is not known whether this is a natural phenomenon or the result of irrigation withdrawals (Mendel, G. 2000 Personal Communication).

Change in Flow Regime

See "Water Quantity/Dewatering" above.

Biological Processes

See Lower Walla Walla Subbasin Common Habitat Characteristics for biological processes shared by many streams in the Walla Walla Basin. Introduced black locust trees are a common component of riparian buffers along this portion of Dry Creek (Kuttel 2001).

Dry Creek (Hwy. 12 bridge near Smith Road to mouth)

Habitat Ratings

Fish Passage

A large headcut caused by channelization of Dry Creek near the town of Lowden and removal of riparian vegetation created a large barrier known as Dry Creek Falls. See Figure 20 below. This falls was likely a substantial blockage to anadromous fish runs in the past. The falls is no longer believed to exist. It's thought that the headcut may have continued moving upstream and finally leveled out or a huge pulse of sediment may have filled in the headcut. In any case, nobody knows the location of the falls at the present time (TAG 2000 Personal Communication). At least two concrete grade control structures just downstream of the Highway 12 bridge are potential barriers (Tice, B. 2000 Personal Communication).

Screens and Diversions

Preliminary data from the WDFW CCRP identified 21 pump diversions in use on this reach. One pump diversion was identified on Spring Creek, a tributary of Dry Creek (Bireley 2000).

Riparian Condition

Riparian zones along this reach of Dry Creek are characterized by very narrow strips of pole/sapling size vegetation on the old floodplain terrace. Native plants make up the majority of trees and shrubs (Mendel, G. 2000 Personal Communication). Deep channel incision has eliminated large woody debris recruitment from the buffer along the majority of this reach (TAG 2000 Personal Communication).

Streambank Condition

Streambanks along this reach of Dry Creek are highly unstable. Some reaches have downcut 40 to 50 feet below the old floodplain in response to channel straightening and removal of riparian vegetation (Reckendorf 2000). Intermittent tributaries on the right bank of Dry Creek (looking downstream) are deeply incised and likely make significant contributions of fine sediment to the system (TAG 2000 Personal Communication). Figure 20 below illustrates the severity of channel incision on Dry Creek.

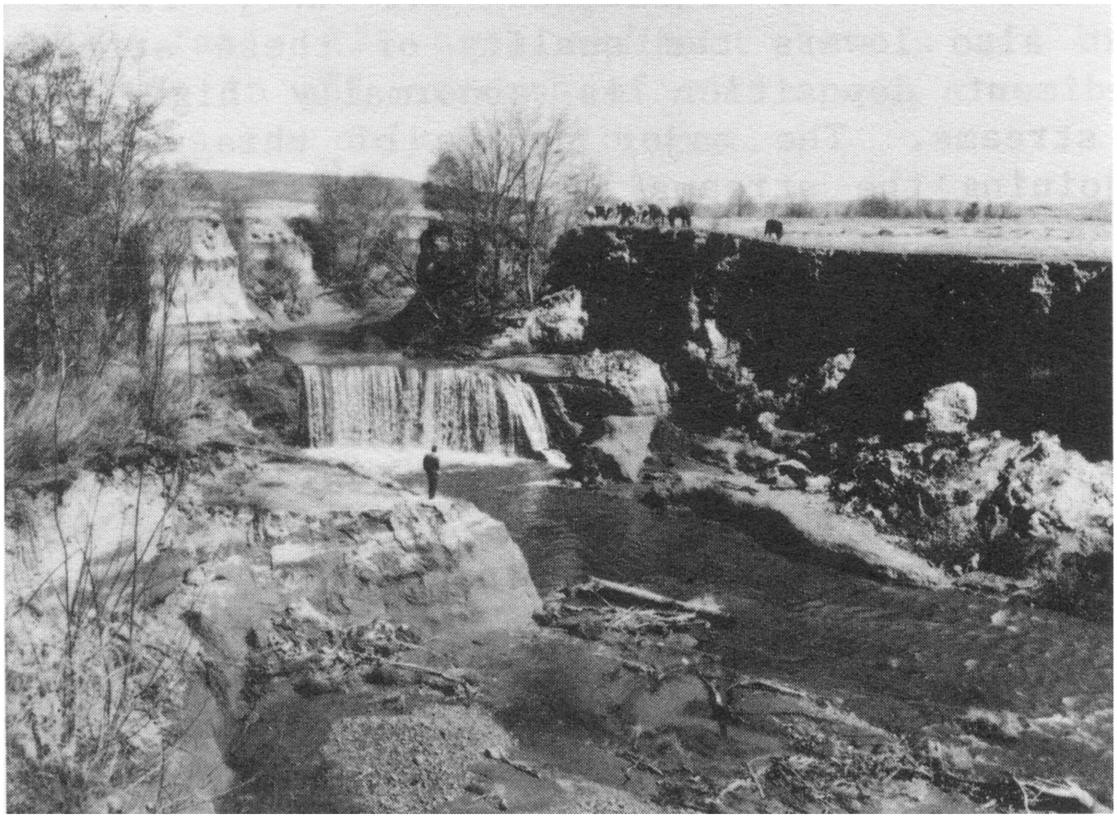

Figure 20. Dry Creek Falls showing severe channel incision. Source: USDA Soil Conservation Service et al. 1984. Photograph date unknown.

Floodplain Connectivity

Streambanks along this reach of Dry Creek are highly unstable. Some reaches have downcut 40 to 50 feet below the old floodplain in response to channel straightening and removal of riparian vegetation (Reckendorf 2000). See the photo of Dry Creek Falls above.

Width/Depth Ratio

No data on width/depth ratio were available.

Substrate Embeddedness

As of 1984 252,000 tons/yr fine sediment were delivered from cropland to streams in the Dry Creek Basin. For comparison, forestlands delivered 354 tons/yr. In 1981, 75% of nonirrigated cropland in the Dry Creek watershed had an erosion rate >5 tons/acre/yr (the maximum soil erosion rate allowable to maintain sustainable agricultural production). (USDA Soil Conservation Service *et al.* 1984). Substrate is highly embedded to completely covered with mud on this reach (Mendel, G. and D.Karl 2000 Personal Communication).

Large Woody Debris

Large woody debris (LWD) is lacking along this reach. This is likely the result of stream cleanouts, a lack of riparian vegetation along stream banks, and severe downcutting of the channel that has eliminated access to much of the floodplain, thereby limiting LWD recruitment (TAG 2000 Personal Communication).

Pool Frequency

The narrow incised channel and relatively flat gradient may yield a high pool frequency (Mendel, G. 2000 Personal Communication).

Pool Quality

Low flows cause stagnant conditions during the summer months (Mendel, G. 2000 Personal Communication).

Off-Channel Habitat

Off-channel habitat is nearly nonexistent along this reach because of severe channel incision that has created steep banks and eliminated access to the majority of the historic floodplain (Mendel, G. and D.Karl 2000 Personal Communication). See Figure 20 above.

Water Quality/Temperature

Maximum temperatures frequently exceeded 85°F during the summers of 1999 and 2000. Average temperatures were >70°F from mid June through late August (Mendel *et al.* 2000; Mendel and Karl 2000). Dry Creek carries a huge fine sediment load eroded from dryland agricultural fields throughout the drainage (USDA Soil Conservation Service *et al.* 1984).

Water Quantity/Dewatering

Dry Creek has very low summer flows, causing mostly standing and/or stagnant water (Mendel, G. 2000 Personal Communication).

Change in Flow Regime

A minimum of 21 irrigation diversions are known to be in use on this reach of Dry Creek. These water withdrawals have undoubtedly changed the flow regime, but a lack of historic flow records makes it impossible to assess the extent of the change.

Biological Processes

Dry Creek was suspected to be a meadow type stream prior to European settlement (Mendel, G. 2000 Personal Communication). Beaver are commonly associated with this type of habitat and were historically present in large numbers throughout Southeast Washington (Lewis and W.Clark 1893; Meinig 1968; Saul *et al.* 2000). See Lower Walla Walla Subbasin Common Habitat Characteristics for further details regarding beaver and anadromous fish carcasses. Non-native reed canary grass and black locust trees are also present on this reach.

Mill Creek (Bennington Lake Diversion Dam to mouth)

Habitat Ratings

Fish Passage

U.S. Army Corps of Engineers (1997) lists three full channel spanning and three partial channel spanning barriers on this reach. A grade control structure located at Gose Road bridge is a barrier (Montgomery Watson 1999). See Figure 21 below. Mill Creek has been channelized since 1948 from Bennington Lake Diversion Dam downstream to Gose Road (U.S. Army Corps of Engineers 1988). See Mill Creek Channel Diagram. The upper and lower portions of this wide channel are characterized by riprapped banks and cross weirs spaced about every 100 feet. The middle portion of the channel (through the City of Walla Walla) is concrete lined with a low flow channel and baffles placed at regular intervals in an attempt to allow fish passage. See Figure 22. The channelized reach goes dry (or nearly dry) about a mile below Bennington Lake Diversion Dam (just below the Yellowhawk/Garrison Creek division dam) during the summer months as a result of flows being diverted to Yellowhawk and Garrison Creeks. Juvenile passage is likely impeded through this reach during both low and high flow conditions (impassable during summer months because of dewatering) (TAG 2000 Personal Communication).

Figure 21. Grade control structure under Gose Road Bridge over Mill Creek. Photo taken summer of 2000.

Screens and Diversions

Preliminary data from the WDFW CCRP identified 13 pump and 6 gravity diversions in use on this reach of Mill Creek in addition to the diversions discussed below. Cold (5 pump and 1 gravity) and Doan Creeks (4 pump and 1 gravity), both small LB tributaries of Mill Creek near its mouth are home to numerous diversions as well (Bireley 2000). The diversion to Bennington Lake was screened to NMFS criteria in 2000 (Tice, B. 2001 Personal Communication). The Yellowhawk/Garrison Diversion is not screened. This issue will be examined further. Yellowhawk Creek is used as a bypass corridor for salmonids to get around the channelized portion of Mill Creek. This option may be further developed by screening off Mill Creek at the upper and lower ends of the channelized reach (TAG 2000 Personal Communication). Stiller Diversion is located on the right bank of Mill Creek at RM 2.5. Water flows about 200' down a ditch to the existing screen. The screen mesh is too large and the surface area is too small. The juvenile bypass is a capped off PVC pipe with no identifiable outfall (Montgomery Watson 1999). Jones Ditch is located at RM 11.0 on Mill Creek below Rooks Park. An unscreened headgate on the left bank levee directs flow through a 2.5' diameter corrugated metal pipe culvert (Montgomery Watson 1999).

Riparian Condition

Riparian vegetation is sparse and disconnected from the stream by the Mill Creek flood control project downstream to Gose Road. Many areas of the channel through town are surrounded or covered by buildings. Vegetation is actively managed to discourage growth on the dikes in the flood control project (TAG 2000 Personal Communication). Vegetation in the Mill Creek project area is dominated by Russian olive *(Elaeagnus angustifolia)*, black locust *(Robinia pseudo-acacia)*, Austrian pine *(Pinus nigra)*, Siberian peashrub *(Caragana arborescens)*, and serviceberry *(Amelanchier sp.)*. The four former species are non-native. They were planted by the Washington Department of Game (now Washington Department of Fish and Wildlife) in the 1950's to provide wildlife habitat. Native species including black cottonwood, willow, and rose have recolonized the area (U.S. Army Corps of Engineers 1988). Trees are adjacent to the stream below Gose Road, but the buffer is narrow with trees primarily growing up out of the incised stream channel, rather than on the floodplain.

Streambank Condition

The Mill Creek flood control project confines the channel with riprap and concrete lined banks, thereby preventing natural channel evolution processes (lateral migration, meandering, floodplain inundation, large woody debris recruitment, etc.). This type of man-made bank stability provides little to no fish habitat value (Northrop 1999, U.S. Army Corps of Engineers 1997). Streambanks on this reach do not erode, but they are of little value to salmonids. See Figure 22 below.

Figure 22. Mill Creek below 3rd. Avenue in Walla Walla. Photo taken February 2001.

Floodplain Connectivity

The Mill Creek flood control project confines the channel with riprap and concrete lined banks and dikes to protect the cities of Walla Walla and College Place. This channelization and floodplain development has eliminated natural floodplain processes (Northrop 1999; U.S. Army Corps of Engineers 1997). See Figure 22 above.

Width/Depth Ratio

The channelized portion of Mill Creek from Bennington Lake Dam downstream to Roosevelt Street and again from 9th Avenue downstream to Gose Road is very wide and shallow. The concrete channel between Roosevelt Street and 9th Avenue is very narrow and deep (TAG 2000 Personal Communication). The shallow portions make salmonids easy prey for predatory birds such as kingfishers and herons, while the concrete channel creates velocities much too high for salmonid passage during periods of the fall and winter months (TAG 2000 Personal Communication).

Substrate Embeddedness

Substrate embeddedness in the channelized portion of Mill Creek is very poor because of the concrete lined channel. The portions of “improved” channel above Roosevelt Street and below 9th Avenue have highly cemented gravels and cobbles and extensive reed canary grass beds (TAG 2000 Personal Communication).

Large Woody Debris

Large woody debris (LWD) is nearly nonexistent on this reach. Bennington Lake Diversion Dam and the Yellowhawk Division Dam prevent recruitment of woody material from upstream. Dikes along the channelized portion of the creek prevent woody debris recruitment from flooding or trees falling into the stream. Moreover, woody debris that makes it into this reach is likely removed by the Corps of Engineers to maintain channel capacity (TAG 2000 Personal Communication).

Pool Frequency

Portions of the channelized reach (below Yellowhawk/Garrison Division) go dry (or nearly dry) during the summer. Any pools present are small pools behind large rocks or plunge pools below the concrete capped gabions and sheet piling weirs above the Yellowhawk/Garrison Creek Division or behind baffles in the low flow “thalweg” of the concrete channel (TAG 2000 Personal Communication).

Pool Quality

Pools on the channelized reach are generally small with little habitat complexity. Most of these pools are 1 foot or less in depth and have little or no overhanging or instream cover (TAG 2000 Personal Communication).

Off-Channel Habitat

The Mill Creek flood control project confines the channel with riprap and concrete lined banks and dikes to protect the cities of Walla Walla and College Place. This channelization and floodplain development has eliminated off-channel habitat (Northrop 1999; U.S. Army Corps of Engineers 1997).

Water Quality/Temperature

Fine sediment inputs from sheet and rill erosion of cropland are a serious problem throughout the Lower Walla Walla Subbasin (USDA Soil Conservation Service *et al.* 1984). Dewatering, a high width/depth ratio, degraded riparian conditions, and an abundance of concrete and riprap (trap heat) all contribute to high water temperatures in lower Mill Creek. In 1999, daily maximum water temperatures frequently approached 75°F (24.0°C) and averaged >65°F during the month of August, although cold springs of about 55°F entered the concrete channel in several locations (Mendel *et al.* 2000; Tice 2000). High chlorine levels create suboptimal conditions for salmonids from Gose Road upstream to the City of Walla Walla sewage treatment plant. Aquatic life was periodically restricted to areas away from the chlorine outfalls during 1998 WDFW electrofishing sampling on Mill Creek (Mendel *et al.* 1999). Effluent from the City of Walla Walla sewage treatment plant is the chlorine pollution point-source (Neve, W. 2000 Personal Communication).

Water Quantity/Dewatering

The majority of this reach goes nearly dry during the summer as a result of diversion of flows to Yellowhawk and Garrison Creeks for irrigation purposes (Northrop 1999, U.S. Army Corps of Engineers 1997). Springs in the Walla Walla City limits and outflow from the City of Walla Walla sewage treatment plant prevent complete drying of the channel (TAG 2000 Personal Communication, Northrop 1998). See Figure 11.

Change in Flow Regime

The majority of this reach goes dry during the summer as a result of diversion of flows to Yellowhawk and Garrison Creeks for irrigation purposes (Northrop 1999, U.S. Army Corps of Engineers 1997). A change in flow regime has definitely occurred as a result of irrigation activities.

Biological Processes

The Mill Creek Flood Control Project makes salmonids vulnerable to avian predators such as kingfishers and herons because of wide shallow channels and little to no overhead or instream cover (TAG 2000 Personal Communication). This simplified channel also lacks habitat for small invertebrates that juvenile salmonids feed on, likely limiting the food supply for fish trying to rear in the channel (Tice, B. 2001 Personal Communication). A number of exotic plant species including reed canary grass are present on this reach of Mill Creek (see "Riparian Condition" above). See Lower Walla Walla Subbasin Common Habitat Characteristics .

Yellowhawk and Garrison Creeks

Habitat Ratings

Fish Passage

U.S. Army Corps of Engineers (USACE) (1997) identified four channel spanning barriers on Yellowhawk Creek and two channel spanning barriers on Garrison Creek. At least three barriers are present on Garrison Creek in addition to the barriers identified by the USACE. A concrete dam at the outlet of Lion's Park pond in College Place is a substantial barrier. A culvert that runs under Larch Street and an ornamental pond immediately downstream from Larch Street are also barriers (Kuttel 2001). See Figure 23 below. Garrison Creek is highly urbanized with numerous ornamental water gardens and water wheels in place on the creek. Yellowhawk Creek is less urbanized than Garrison Creek (TAG 2000 Personal Communication). Falbo Ditch is located on Yellowhawk Creek 0.3 miles upstream from Walla Walla High School. Water spills over a 4'high diversion dam onto a concrete apron. Williams Ditch is located on the left bank of Yellowhawk Creek about 700' downstream from the Union Pacific railroad crossing. The concrete diversion dam spans the entire channel. Water spills on a concrete apron perched 2.5' above the stream channel (Montgomery Watson 1999). Walla Walla Conservation District (WWCD) has scheduled instream work to correct the passage problems at Falbo and Williams Ditches for the summer of 2001 (Smith, L. 2000 Personal Communication). The City of College Place has eliminated one of the two barriers listed above on Garrison Creek (Neve, W. 2000 Personal Communication).

Figure 23. Lion's Park Pond Dam on Garrison Creek. Photo taken February 2001.

Screens and Diversions

Preliminary data from the WDFW CCRP identified 34 pump and three gravity diversions on Yellowhawk Creek along with 27 pump and seven gravity diversions on Garrison Creek. Caldwell Creek (small LB tributary of Yellowhawk Creek) has three pump diversions and one gravity diversion thought to be in use (Bireley 2000). Walla Walla Conservation District (WWCD) installed fish screens that meet criteria on the Falbo and Williams diversions in the summer of 2000 (Smith, L. 2000 Personal Communication).

Riparian Condition

Yellowhawk Creek flows through both highly urbanized areas and relatively natural riparian areas, while the majority of Garrison Creek is urbanized (TAG 2000 Personal Communication).

Streambank Condition

Streambanks on Yellowhawk Creek are very unstable; 43% of banks assessed were actively eroding (Reckendorf, F. and Tice 2000). Unstable banks are attributed to urban development and increased flows from irrigation diversions out of Mill Creek (TAG 2000 Personal Communication). No information was available for Garrison Creek bank condition.

Floodplain Connectivity

Flows on both streams are controlled year-round, preventing “flushing flows” that would clean gravel and reduce embeddedness (Mendel, G. 2001 Personal Communication).

Urban development and regulations of flows both severely limit floodplain connectivity (TAG 2000 Personal Communication).

Width/Depth Ratio

Both Yellowhawk Creek and Garrison Creek are fairly narrow channels with reasonable depth (Mendel, G. 2000 Personal Communication).

Substrate Embeddedness

Gravels and cobbles in both Yellowhawk and Garrison Creeks are highly cemented by fine sediment. Both streams are intensively managed for irrigation water flows, eliminating peak flows that would normally act to break up substrate paving (TAG 2000 Personal Communication).

Large Woody Debris

Yellowhawk Creek is deficient of large woody debris (LWD) as are many other streams in the Walla Walla Basin. Only 12.6 pieces of LWD per mile were counted on assessed reaches of Yellowhawk Creek (Reckendorf, F. and Tice 2000). Large woody debris is even less common on Garrison Creek (Mendel, G. 2000 Personal Communication).

Pool Frequency

Yellowhawk Creek lacks pools. Reckendorf and Tice(2000) measured 22.5 pools per mile on assessed reaches of Yellowhawk Creek with an average wetted channel width of 5 to 10 feet.

Pool Quality

The pools present on Yellowhawk Creek are of fair quality with a mean pool quality index of 3.2 (Reckendorf, F. and Tice 2000). See RAPFAHRS in Appendix C.

Off-Channel Habitat

Off-channel habitat is very limited on Yellowhawk Creek and worse or non existent on Garrison Creek. Urbanization has eliminated a great deal of floodplain connectivity (TAG 2000 Personal Communication).

Water Quality/Temperature

Garrison Creek temperatures routinely exceeded 75°F (24.0°C) in July and August 1999 and 2000. Yellowhawk Creek maximum temperatures in 1999 and 2000 routinely exceeded 70°F ((Mendel *et al.* 2000; Mendel and Karl 2000, Tice 2000).

Water Quantity

Garrison Creek went dry in places during the 1999 irrigation season as a result of surface water withdrawals and flow regulation from Mill Creek (TAG 2000 Personal Communication). However, Garrison Creek and Yellowhawk Creeks would go dry during the summer months without the additional water diverted from Mill Creek (Neve, W. 2000 Personal Communication).

Change in Flow Regime

The summer flow regime of Yellowhawk and Garrison Creeks has been altered by additional flow input diverted from Mill Creek. Without the additional flow, both streams would go dry in the summer months (Neve, W. 2000 Personal Communication). Regulation of flows in Yellowhawk and Garrison Creeks has eliminated "flushing" flows that would remove fine sediment from the substrate (Tice, B. 2001 Personal Communication, Mendel, G. and D.Karl 2000 Personal Communication).

Biological Processes

Beaver are present on Yellowhawk Creek and Garrison Creeks (TAG 2001 Personal Communication) and could be of value on upstream or less urbanized reaches (Mendel, G. 2000 Personal Communication). See Lower Walla Walla Subbasin Common Habitat Characteristics.

Cottonwood, Russell, and Reser Creeks

Habitat Ratings

Fish Passage

A dam at approximately RM 4.5 on Russell Creek is a complete barrier to upstream passage (Mendel, G. and D.Karl 2000 Personal Communication). No barriers were identified on Cottonwood Creek.

Screens and Diversions

Preliminary data from the WDFW CCRP identified one gravity diversion and eight pump diversions in use on Cottonwood Creek. Seven pump diversions were identified on Russell Creek (Bireley 2000).

Riparian Condition

All three of these streams flow through vast areas of dryland agriculture. In many cases the land has been farmed to the edge of the streambank, leaving no riparian buffer on the floodplain. Where woody vegetation is present it is usually found in a thin strip, often growing up out of an incised stream channel (Tice, B. 2001 Personal Communication, Kuttel 2001). Cottonwood Creek originates in wooded ravines in the Oregon portion of the Blue Mountains. The Washington portion of the stream has a narrow strip of riparian vegetation along much of its length (Mendel, G. 2001 Personal Communication). See Figure 24 below.

Figure 24. Riparian zone on Russell Creek next to Scenic Loop Road. Photo taken January 2001.

Streambank Condition

No information on streambank condition was available, but incised stream channels and a nearly uniform lack of functioning riparian buffers makes it likely that banks are unstable (Kuttel 2001).

Floodplain Connectivity

Many reaches of these streams are deeply incised as a result of removal of riparian vegetation from the historic floodplain (Tice, B. 2001 Personal Communication, Kuttel 2001). The lower portion of Cottonwood Creek has been diked (Mendel, G. 2001 Personal Communication).

Width/Depth Ratio

Cottonwood Creek near Powerline Road is very wide and shallow. No riparian buffer is present along this reach. The channel has also been straightened. It appears that this stream is subject to high flow events in the winter that combined with the straight channel and lack of riparian vegetation led to creation of an excessively wide channel. Many reaches on Russell and Reser Creeks are deeply incised (Tice, B. 2001 Personal Communication, Kuttel 2001). See Figure 25 below.

Figure 25. Cottonwood Creek above Powerline Road. Photo taken January 2001.

Substrate Embeddedness

No data on substrate embeddedness are available.

Large Woody Debris

No information on large woody debris is available.

Pool Frequency

No information on pool frequency is available.

Pool Quality

No information on pool quality is available.

Off-Channel Habitat

No data on off-channel habitat are available.

Water Quality/Temperature

Temperatures routinely exceeded 75°F (24.0°C) on Cottonwood Creek in July and August 1999. Temperatures on Russell Creek rarely exceeded 70°F (21.1°C) in July and August 1999 and 2000 (Mendel *et al.* 2000, Tice 2000).

Water Quantity/Dewatering

Cottonwood Creek from the mouth to the stateline and portions of Reser Creek go dry during the summer (TAG 2000 Personal Communication).

Change in Flow Regime

The natural flow regime of Cottonwood Creek has been altered. Irrigation withdrawals, lack of riparian vegetation, and channel modifications have all contributed to the dewatering described above (TAG 2001 Personal Communication).

Biological Processes

See Lower Walla Walla Subbasin Common Habitat Characteristics .

LOWER WALLA WALLA SUBBASIN RECOMMENDATIONS

1. Conduct a comprehensive inventory of surface water diversions and ensure compliance with juvenile fish screening regulations.
2. Restore instreamflows on the Walla Walla River from the stateline downstream, Mill Creek below Yellowhawk Division, and Cottonwood Creek.
3. Restore floodplain connectivity and natural channel migration through removal or set back of dikes and removal of bank armoring.
4. Replant native riparian vegetation along streams beginning on the upper reaches of spawning and rearing areas, then progressing downstream to lower priority migration areas.
5. Restrict installation of instream habitat projects to small tributary streams that currently support summer rearing of salmonids.
6. Increase irrigation efficiency and/or convert irrigated crops to dry farmed crops.
7. Replace push-up dams with more permanent structures that reduce streambed disturbance and provide fish passage.
8. Reduce fine sediment inputs to streams through replacement of conventional tillage with no-till farming or other methods.
9. Protect the remaining functional portions of riparian buffer along Yellowhawk Creek and restore degraded areas.
10. Determine the appropriate management strategy of Mill Creek below Bennington Lake Dam and Yellowhawk Creek, including investigating the feasibility of screening-off Mill Creek at Gose Road and at the Yellowhawk Division. Yellowhawk Creek would then serve as the migration corridor from the Walla Walla River to the Upper Mill Creek Subbasin.
11. Provide flushing flows in Yellowhawk Creek to reduce sediment deposition and improve fish habitat.
12. Enforce land use regulations including the Growth Management Act, Shoreline Management Act, and Critical Area Ordinances.

UPPER MILL CREEK SUBBASIN HABITAT LIMITING FACTORS

Upper Mill Creek Subbasin Description

Mill Creek originates on U.S. Forest Service lands in Washington high in the West flanks of the Blue Mountains. See Map 5 in Appendix B. The upper portion of this creek is protected by the Mill Creek Watershed, an area closed to public entry since 1954, except by special permit in order to protect the municipal water quality of the City of Walla Walla (U.S. Forest Service (USDA) 1996d). Mill Creek dips into Oregon for a short stretch of about 5 miles, then re-enters Washington where it flows to the Bennington Lake Dam east of the City of Walla Walla. No cities or towns are located in this subbasin. Much of the upper portion of the subbasin is remote forest land. The lower portion is characterized by high plateaus where dryland farming is the dominant land use. Irrigated crops such as alfalfa are grown in a few areas of the valley bottom east of Walla Walla. The Upper Mill Creek Subbasin is one of the few remaining areas of refuge for summer steelhead and bull trout in the Walla Walla Basin. Salmonid bearing streams in this subbasin include Blue Creek, Henry Canyon, Webb Creek, Elbow Creek, Tiger Creek, Low Creek, Broken Creek, Paradise Creek, North Fork Mill Creek, Deadman Creek, Burnt Fork, Green Fork, and Bull Creek. Spring chinook were historically present, but are now extinct (Nielson 1950, Mendel *et al.* 1999). See Map 11 and Map 12 in Appendix B.

Mill Creek (Headwaters to Bennington Lake Diversion Dam)

Habitat Ratings

Fish Passage

A diversion dam operated by the City of Walla Walla for its municipal water supply and the remains of the old diversion dam at Kooskooskee are the only obstructions identified on this reach. The water supply dam has an operational fish ladder (Northrop 1998; Reckendorf, F. and Tice 2000), but the City is currently in consultation with the U.S. Fish and Wildlife Service for "take" of threatened bull trout at the diversion facility. Several radio tags from bull trout marked in a radio telemetry study were found in the trash rack of the diversion (Grandstaff, M. 2000 Personal Communication). An ornamental pond at Walla Walla Community College, numerous diversion structures, and livestock access cause juvenile passage barriers on the lower 2.7 miles of Titus Creek (Montgomery Watson 1999).

Screens and Diversions

Preliminary data from the WDFW CCRP identified 13 pump and two gravity diversions in use on Titus Creek downstream from 5 Mile Road. Blue Creek (small RB tributary at RM 16.9) has two pump diversions in use. Mill Creek has six pump and three gravity diversions in use on this reach (Bireley 2000).

Riparian Condition

Much of Mill Creek upstream of the U.S. Forest Service boundary is protected by the Mill Creek Watershed. Riparian vegetation within "the watershed" is dominated by large

Douglas-fir, white fir, grand fir, and alder trees. Logging in this area has been restricted to the outer rim of the watershed. No livestock grazing has occurred since 1925 (U.S. Forest Service (USDA) 1996d). Riparian zones downstream of the U.S. Forest Service boundary are a mixture of deciduous and coniferous trees with varying degrees of disturbance depending upon property ownership (Northrop 1998; Reckendorf, F. and Tice 2000).

<u>Streambank Condition</u>

Streambanks on this reach are relatively stable. The USFS reported 87% of banks along 4.3 miles of stream assessed as stable (U.S. Forest Service (USDA) 1996d). Reckendorf and Tice(2000) described 86.6% (13.4% actively eroding) of banks assessed on private lands downstream as stable.

<u>Floodplain Connectivity</u>

The floodplain is fully connected on the portion of stream flowing through USFS lands (Northrop 1998). Roads and dikes limit floodplain connectivity on private lands below the USFS lands (Tice, B. 2000 Personal Communication).

<u>Width/Depth Ratio</u>

Width/depth ratio on USFS lands was 14.3 (U.S. Forest Service (USDA) 1996d). Some portions of the stream on private lands downstream have been adversely affected by flood control work following the 1996-1997 floods (TAG 2000 Personal Communication).

<u>Substrate Embeddedness</u>

Cobble embeddedness on USFS lands averaged 16% on Mill Creek between the City of Walla Walla intake at RM 25.2 and the mouth of North Fork Mill Creek (U.S. Forest Service (USDA) 1996d). This same reach was evaluated in 1991. Embeddedness was reported at ≤ 5% (Underwood *et al.* 1995).

<u>Large Woody Debris</u>

Large woody debris is deficient throughout this reach. LWD averaged 9.7 pieces per mile on USFS lands and 11.6 pieces per mile downstream on private lands (U.S. Forest Service (USDA) 1996d, Reckendorf, F. and Tice 2000).

<u>Pool Frequency</u>

Pools are infrequent on this reach. Pool frequency averaged 20.6 pools per mile on USFS lands (16.5% stream surface area) and 18.1 pools per mile on private lands (U.S. Forest Service (USDA) 1996d, Reckendorf, F. and Tice 2000).

<u>Pool Quality</u>

Pools on USFS lands average 1.9’ residual pool depth (U.S. Forest Service (USDA) 1996d). Pools on private lands are of moderate depth with some cover (Reckendorf, F. and Tice 2000).

Off-Channel Habitat

Some ponds and backwaters are present along this reach (Northrop 1998). Side channels comprised 3.6% of stream surface area on USFS lands (U.S. Forest Service (USDA) 1996d). The forebay area of Bennington Lake Diversion Dam (upstream side) has created a large delta area with several meandering stream channels. Beaver are also present, contributing to high quality salmonid rearing habitat (Tice, B. 2001 Personal Communication).

Water Quality/Temperature

Temperatures ranged between 60°F (15.6°C) to 73°F (22.8°C) in August 1999 (Mendel *et al.* 2000) and 65°F (18.3°C) to 73°F (22.8°C) (Tice, B. 2000 Personal Communication). *Note: these temperatures were recorded at 5 mile Bridge near the lower end of the reach.* Temperatures on USFS lands upstream are much cooler. From mid June to mid September 1991 maximum water temperatures rarely approached 54°F (Martin 1992).

Water Quantity/Dewatering

Perennial flows are present throughout the majority of this reach. However, a gravity diversion into Titus Creek (RM 14.3) does cause complete dewatering (in the vicinity of the diversion only) during the summer months (Tice, B. 2001 Personal Communication). Migration of the Mill Creek channel has resulted in erosion of the right bank, causing the majority of Mill Creek flow to be directed into Titus Creek. A push-up dam about 500 yards down Titus Creek directs about 10 cfs of flow back into Mill Creek below the dewatered stretch (Montgomery Watson 1999).

Change in Flow Regime

The City of Walla Walla has a diversion dam located at approximately RM 25.2 (Northrop 1998). The city has a 20 cfs water right for this location (Washington Department of Ecology 2000b). Diversion of summer flows down Titus Creek alters the flow regime as well (TAG 2001 Personal Communication).

Biological Processes

Beavers were historically present in large numbers throughout Southeast Washington (Lewis and W.Clark 1893); Meinig 1968; Saul *et al.* 2000). Beaver ponds provide off-channel habitat, maintain wetlands, recharge shallow aquifers, and moderate stream flow regimes (Lichatowich 1999). The beaver population in the Walla Walla Basin (and throughout Southeast Washington) was nearly exterminated by fur trappers by 1835 (Meinig 1968). The absence of beaver in the Walla Walla Basin is being evidenced today by a lack of off-channel habitat, few wetlands, and stream flow regimes with high winter peaks and low summer flows (and associated high temperatures). Beaver are a significant link missing from the ecosystem in the Walla Walla Basin (Saul *et al.* 2000). Anadromous fish runs are far less abundant today than historically. Low numbers of decomposing fish carcasses likely limit productivity in the subbasin (Mendel, G. 2000 Personal Communication, Tice, B. 2000 Personal Communication).

Upper Mill Creek Tributary Streams (North Fork Mill Creek, Paradise Creek, Broken Creek, Low Creek, Tiger Creek)

Note: The following sections were developed entirely with USFS data from the following sources (U.S. Forest Service (USDA) 1996e, U.S. Forest Service (USDA) 1996f, U.S. Forest Service (USDA) 1996b, U.S. Forest Service (USDA) 1996c, and Hines 1993).

Habitat Ratings

Fish Passage

No barriers were identified

Screens and Diversions

No diversions are present within the "Mill Creek Watershed" with the exception of the City of Walla Walla intake described in the previous reach.

Riparian Condition

Riparian vegetation along these streams is dominated by large and or mature trees including white fir, grand fir, and alder. However, Tiger Creek riparian vegetation is primarily small trees, saplings, and shrubs dominated by grand fir and alder. Canopy cover on Tiger Creek averaged 87%.

Streambank Condition

The following bank stability measurements were reported for Broken Creek, Paradise Creek, North Fork Mill Creek and Low Creek respectively: 59.8%, 66.2%, 84.0%, 96%. Bank stability values were not found for Tiger Creek.

Floodplain Connectivity

Dikes and bank armoring are not present on any of these streams. These streams should be fully connected to their floodplains.

Width/Depth Ratio

The following width/depth ratios were reported for Broken Creek, Paradise Creek, North Fork Mill Creek, Low Creek, and Tiger Creek respectively: 13.6, 15.3, 7.8, 10.24, 6.5.

Substrate Embeddedness

The following cobble embeddedness values were reported for Broken Creek, Paradise Creek, North Fork Mill Creek, Low Creek, and Tiger Creek respectively: 25%, 19%, 24%, 17%,20%.

Large Woody Debris

The following quantities of LWD per mile were reported for Broken Creek, Paradise Creek, North Fork Mill Creek, Low Creek, and Tiger Creek respectively: 51.8, 35.6, 14.7, 19.0, 47.

Pool Frequency

Pools comprised the following percentage of stream surface area for Broken Creek, Paradise Creek, North Fork Mill Creek, Low Creek, and Tiger Creek respectively: 26.3%, 24.4%, 16.8%, 17.5%, 5.3%. Pools per mile values were as follows for Broken Creek, Paradise Creek, Low Creek, and Tiger Creek respectively: 84.6, 80.4, 79.6, 19.2.

Pool Quality

Average residual pool depth ranged from 0.82' to 1.5' for all streams.

Off-Channel Habitat

A surprising amount of off-channel habitat is present on these streams. Tiger Creek had the smallest amount of off-channel habitat with 1.2% of stream surface area in side channels, while Paradise Creek had the most off-channel habitat with 11.6% of stream surface area in side channels.

Water Quality/Temperature

No long-term temperature trend data are available for these streams, but the "pristine" nature of the "Mill Creek Watershed" suggests that water temperatures would be favorable for all salmonid lifestages.

Water Quantity/Dewatering

The "Mill Creek Watershed" is a remote forest area with very limited public entry. No surface water diversions are present with the exception of the City of Walla Walla intake at RM 25.2 on Mill Creek. Water quantity should not be an issue in the tributary streams.

Change in Flow Regime

The "pristine" nature of the "Mill Creek Watershed" suggests that the natural flow regime should still be present.

Biological Processes

No exotic plant or animal species were noted to be present in the tributary streams. A lack of nutrients contributed by decaying anadromous fish carcasses is likely the only biological process of concern.

UPPER MILL CREEK SUBBASIN RECOMMENDATIONS

1. Conduct a comprehensive inventory of surface water diversions and ensure compliance with juvenile fish screening regulations.
2. Continue to protect quality salmonid habitat within the "Mill Creek Watershed."
3. Restore floodplain connectivity and natural channel migration on private lands through removal or set back of dikes and removal of bank armoring.
4. Place large woody debris and other instream habitat structures to improve pool frequency and quality.
5. Replace push-up dams with more permanent structures that reduce streambed disturbance and provide fish passage.
6. Protect quality salmonid habitat from Blue Creek upstream.
7. Maintain the wetland complex found above Bennington Lake Diversion Dam.
8. Reduce sediment delivery to Blue Creek.
9. Enforce land use regulations including the Growth Management Act, Shoreline Management Act, and Critical Area Ordinances.

OREGON WALLA WALLA SUBBASIN HABITAT LIMITING FACTORS

A detailed assessment of salmonid habitat conditions in the Oregon Walla Walla Subbasin was hampered by several factors including: a general scarcity of published habitat assessments, lack of jurisdiction, and time constraints. None-the-less, actions taking place in the Oregon portion of the Walla Walla Watershed have effects on habitat conditions downstream in Washington. The following section will describe the most notable habitat impacts occurring in the Oregon Walla Walla Subbasin. A reach by reach assessment was not undertaken for this *(except on USFS lands).*

Oregon Walla Walla Subbasin Description

The Oregon Walla Walla Subbasin encompasses the Walla Walla River and all tributary stream reaches within the Oregon portion of the Walla Walla Watershed. See Map 6 in Appendix B. The city of Milton-Freewater is the largest population center in the subbasin. Landuse ranges from irrigated orchards and alfalfa along streams to dryland farming of wheat at low to mid elevations. Logging, some livestock grazing, and recreation are the dominant land uses in high elevation forest lands. Large scale irrigated agriculture has been a significant portion of the economy in this subbasin since the 1860's to 1880's. The area has large deposits of fertile soils, but precipitation is sparse during the growing season — making irrigation necessary for crop production (Saul *et al.* 2000). **The Walla Walla River from Milton-Freewater (at the source of the Little Walla Walla River) to just north of the stateline (approximately 6 miles downstream) has historically been dewatered during the summer months as a result of irrigation withdrawals since about 1880 (Nielson 1950). See "Water Quantity/Dewatering" below.** A large unconfined gravel aquifer that underlies the area roughly from Milton-Freewater downstream to the town of Touchet, Washington is highly connected to the river through hydraulic continuity (Pacific Groundwater Group 1995). Gravel mining on both sides of the stateline is suspected to have enhanced this continuity, increasing the severity of surface water loss to the aquifer (Neve, W. 2000 Personal Communication).

The South Fork Walla Walla River is one of the last remaining areas of refugia for summer steelhead and bull trout in the Walla Walla Basin (Saul *et al.* 2000), although bull trout were confirmed in the North Fork Walla Walla in 2000 (TAG 2001 Personal Communication). Summer steelhead/rainbow trout are found throughout the subbasin wherever flows are adequate for fish utilization (Germond, J. 2000b Personal Communication). Bull trout are also widely dispersed in these streams. Low stream flows in summer and early fall have substantially limited opportunities for bull trout migration throughout the subbasin. The migratory portion of the bull trout life history (fluvial, adfluvial or possibly anadromous) may be severely reduced, although large adult bull trout are occasionally observed migrating upstream in the mainstem Walla Walla River (Buchanan *et al.* 1997; Mendel, G. 2000 Personal Communication). Spring Chinook were historically present in the basin but were extirpated between the 1930's and 1950's (Nielson 1950, Mendel, G. 2000 Personal Communication). Salmonid bearing streams in this subbasin include the mainstem Walla Walla River, the North and

South Forks of the Walla Walla River, Couse Creek, Little Meadow and Big Meadow Canyons (tributaries of the North Fork Walla Walla River), and the following tributaries of the South Fork Walla Walla River: Elbow Creek, Tamarack Basin, Bear Creek, Kees Canyon, Burnt Cabin Creek, Skiphorton Creek, Reser Creek, and several unnamed streams. See Map 11 and Map 12 in Appendix B.

Oregon Walla Walla Subbasin Common Habitat Characteristics

Screens and Diversions

Today the majority of diversions along the Walla Walla mainstem within the subbasin are screened to NMFS screening criteria (Johnson, T. 2000 Personal Communication, Bailey, T. 2000 Personal Communication). The Little Walla Walla River system has been highly developed with an extensive network of irrigation canals. About 280 points of diversion (PODs) are known to be present in the Oregon portion of the Walla Walla Watershed, the majority of these are located on the Little Walla Walla River system (Justus, T. 2001 Personal Communication). The source point (above Nursery Bridge) of the Little Walla Walla River is screened to prevent juvenile salmonids from entering the system from above (Germond, J. 2000a Personal Communication) and barriers present throughout the system hinder and/or prevent juvenile salmonids from entering the Oregon portion of the Little Walla Walla River system from downstream (Johnson, T. 2000 Personal Communication), but juvenile steelhead and/or redband/rainbow trout are still known to be present in the system. It is not currently known how the fish are getting into the system (Germond, J. 2000a Personal Communication), but the issue should be investigated to ensure that juvenile salmonids do not become trapped in the extensive irrigation network.

Water Quantity/Dewatering

A 1936 U.S. Supreme Court Decision gave Oregon irrigators the right to remove all flow from the Walla Walla River prior to its entry into Washington (George G. Hannan *et al.* 1931). Historically flows from the Walla Walla River were diverted into the Little Walla Walla River system (originally a natural distributary of the Walla Walla) which has been extensively developed with a large network of irrigation canals. Diversion of flows resulted in a dry or nearly dry stretch from Nursery Bridge (located below the Little Walla Walla exit point) downstream approximately six miles. This dewatered reach (commonly called the Tumalum Branch) was a substantial barrier to anadromous fish; in 1935 all diversions below the dewatered reach were screened but diversions upstream were not because few adult salmon and steelhead made it above the dewatered stretch (Nielson 1950).

Dewatering continued until the year 2000 when a civil penalty agreement entered into by Hudson's Bay Improvement District, Walla Walla River Irrigation District, Gardena Farms Irrigation District (Washington), and the U.S. Fish and Wildlife Service required that 13 cfs of flow be passed downstream at Nursery Bridge (note: 10 cfs of flow was required to be passed at Burlingame Dam downstream in Washington) (Durfee, S. 2000 Personal Communication). The additional water left in the channel reduced the "dry" channel from approximately 2 miles in length (in 1999) to approximately one mile in length. Water was visible at the surface, but flow and depth were negligible (Neve, W.

2000 Personal Communication). The added water improved habitat conditions for salmonids on the Oregon side of the stateline (Mendel, G. 2000 Personal Communication). It can take as much as a month for surface flows to reestablish on this reach following completion of the irrigation season (Bureau of Reclamation 1997). The flow conditions described above necessitated a fish rescue operation on several occasions. See Walla Walla River Fish Rescue in the Stock Status Chapter. Low summer flows are also a problem on Couse Creek, Dry Creek (Pine Creek tributary), and Pine Creek (Bureau of Reclamation 1997).

General Habitat Conditions on Private Lands

In addition to the screening and dewatering issues discussed above, streams flowing through private lands in this subbasin are subject to the same habitat alterations that have occurred in the Washington portion of the watershed. Land use practices such as conventional tillage and summer fallow of dry farmed land, clearing of riparian zones, diking and channelization of streams, and removal of LWD have all caused degradation of salmonid habitat (Germond, J. 2000b Personal Communication, Kuttel 2001). No published information exists on the extent of these alterations to habitat on tributaries located on private lands. The ODFW has not assessed salmonid habitat conditions in the Walla Walla Basin (Germond, J. 2000c Personal Communication). A brief description of habitat conditions on the Walla Walla River from the Forks to the stateline and U.S. Forest Service lands follows below.

Walla Walla River (Forks to Stateline)

Habitat Ratings

The Walla Walla River is confined between dikes from the forks downstream to the stateline, a distance of approximately nine miles. The Milton-Freewater flood control project was completed in 1952. The project is comprised of seven miles of channel "improvements." Also included were 18.53 miles of revetted (riprapped) levee, 7.06 miles of channel rectification (removal of LWD, gravel bars, islands, widening of the channel, straightening of the channel, and shaping of the bottom), drainage and irrigation structures, and numerous rock and concrete structures (U.S. Army Corps of Engineers 1951, cited in Saul *et al.* 2000). The historic floodplain along this reach ranged in width from ¼ mile near the forks to over 2 miles from Milton-Freewater to the stateline (U.S. Army Corps of Engineers 1937). Riparian vegetation is removed from the dikes to ensure structural integrity during flood flows. This leaves a large portion of the reach unshaded. The dikes and channel modifications have reduced hydraulic continuity with the floodplain, caused deep channel incision and increased loss of surface water in the channel to the underlying gravel aquifer (TAG 2001 Personal Communication). Numerous push-up dams are present on this reach (U.S. Army Corps of Engineers 1997).

North and South Forks Walla Walla River (on U.S. Forest Service Lands)

Note: The following sections were developed entirely with USFS data from the following sources (U.S. Forest Service (USDA) 1996a, U.S. Forest Service (USDA) 1995).

Habitat Ratings

Fish Passage

No artificial barriers were identified.

Screens and Diversions

No screens and diversions are in use on these reaches.

Riparian Condition

The riparian zone along both streams is dominated by large and/or mature trees including white fir, grand fir, Douglas-fir, and Sitka Spruce.

Streambank Condition

No information on bank erosion was available.

Floodplain Connectivity

Dikes and channel modification activities are not present on these reaches. Floodplain connectivity is assumed to be functioning naturally.

Width/Depth Ratio

The width/depth ratios were 19 and 23 for the North and South Forks respectively.

Substrate Embeddedness

No embeddedness values were available.

Large Woody Debris

LWD pieces per mile averaged 55 and 29 for the North and South Forks respectively.

Pool Frequency

Pools per mile were 77 and 22 for the North and South Forks respectively. Average wetted channel widths were 13.5’ and 23’ respectively.

Pool Quality

Mean residual pool depth was 1.0’ and 1.9’ for the North and South Forks respectively. No information on instream or overhead cover was available.

Off-Channel Habitat

No information on off-channel habitat was available.

Water Quality/Temperature

No information on water quality/temperature was available. Temperatures at Harris Park on the South Fork Walla Walla downstream from USFS lands averaged 49.3°F with a maximum of 59.7°F from June through September 1999 (Tice, B. 2001 Personal Communication). Both of these reaches are bull trout spawning and rearing areas. Bull trout juvenile rearing criteria were used to assess this reach.

Water Quantity/Dewatering

Irrigation does not occur on these reaches. Dewatering likely does not occur unless summer weather conditions are extremely severe.

Change in Flow Regime

The natural flow regime is assumed to be intact.

Biological Processes

No exotic plant or animal species were noted in the literature.

South Fork Walla Walla River Tributary Streams (Burnt Cabin Gulch, Husky Spring Tributary, Reser Creek, Skiphorton Creek, Unnamed LB tributary upstream from Husky Spring Tributary, on U.S. Forest Service Lands)

Note: The following sections were developed entirely with USFS data from the following sources (Lynch 1997a, Lynch 1997b, Lynch 1997c, Lynch 1997d, Lynch 1997e).

Habitat Ratings

Fish Passage

No man-made barriers were identified.

Screens and Diversions

Irrigation does not take place on these streams.

Riparian Condition

The riparian zone along Reser and Skiphorton Creeks is dominated by immature trees and shrubs including white and grand fir. Canopy cover on Reser and Skiphorton Creeks respectively was 48% and 69%. The Husky Spring Tributary riparian zone is characterized by shrub/seedlings, large trees, and mature trees. Grand fir, white fir, subalpine fir, and Engelmann spruce are the dominant species. Canopy cover on Husky Spring Tributary was 84%. The riparian zone along Unnamed LB tributary upstream from Husky Spring Tributary is composed of shrub/seedlings, small trees, and large trees. White fir and grand fir are the dominant species. Canopy cover on this stream was 75%.

Streambank Condition

No information on bank erosion was available.

Floodplain Connectivity

Dikes and channel modifications are not present on these streams. In addition they all flow through relatively narrow canyons with steep gradients. Floodplains are likely small, but functioning properly where present.

Width/Depth Ratio

Width/depth ratios were as follows: 14, 13, 19.2, and 14.4 for Husky Spring Tributary, Reser Creek, Skiphorton Creek, and Unnamed LB tributary stream upstream from Husky Spring Tributary respectively.

Substrate Embeddedness

Embeddedness averaged 27% on Husky Springs Tributary and Reser Creek. Conditions on Skiphorton Creek and Unnamed LB tributary upstream from Husky Spring Tributary were slightly worse with values of 32% and 30% respectively.

Large Woody Debris

Reser Creek had very little LWD as evidenced by a quantity of six pieces per mile. Skiphorton Creek and Husky Spring Tributary had 15 and 25 pieces per mile respectively. Unnamed LB tributary upstream from Husky Spring Tributary had 40 pieces of LWD per mile.

Pool Frequency

Husky Spring Tributary had 76 pools per mile comprising 13.4% of stream surface area. Reser Creek had 36 pools per mile occupying 9.3% of stream surface area. Skiphorton Creek had 32 pools per mile making up 8.5% of stream surface area. Unnamed LB tributary upstream from Husky Spring Tributary had 30 pools per mile comprising 5.8% of stream surface area.

Pool Quality

Mean residual pool depth ranged from a low of 0.8’ on Unnamed LB tributary upstream from Husky Spring Tributary to a high of 1.3’ on Reser Creek. No information on instream or overhead pool cover was available.

Off-Channel Habitat

An assessment of off-channel habitat is not appropriate for these reaches because of high gradients.

Water Quality/Temperature

No information on water quality/temperature was available. Several of these streams are bull trout spawning and rearing areas. Water temperatures are assumed to be favorable because of this habitat utilization.

Water Quantity/Dewatering

No irrigation diversions are present on these streams. Dewatering likely does not occur except under extremely severe summer weather conditions.

Change in Flow Regime

The natural flow regime is assumed to be present because no surface water is removed for irrigation.

Biological Processes

No exotic plant or animal species were identified.

OREGON WALLA WALLA SUBBASIN RECOMMENDATIONS

1. Restore instreamflows on the Walla Walla River from Nursery Bridge downstream to the stateline.
2. Conduct a comprehensive inventory of surface water diversions and ensure compliance with juvenile fish screening regulations, particularly on the highly developed Little Walla Walla River System.
3. Protect the remaining quality salmonid habitat located on USFS lands.
4. Restore floodplain connectivity and natural channel migration on the Walla Walla River from the North/South Fork confluence downstream to the stateline.
5. Implement instream projects on the Walla Walla River from Milton-Freewater downstream to the stateline to reduce surface water loss to the gravel aquifer and create a low flow channel.
6. Restore riparian zones throughout the subbasin.
7. Ensure coordination of flow management on the Little Walla Walla River System near the stateline to prevent stranding or mortality of salmonids in the Washington portion of the system.
8. Reduce fine sediment inputs to streams by replacing conventional tillage with no-till farming practices.

SALMONID HABITAT CONDITION RATING STANDARDS FOR IDENTIFYING LIMITING FACTORS

Under the Salmon Recovery Act (passed by the legislature as House Bill 2496, and later revised by Senate Bill 5595), the Washington Conservation Commission (WCC) is charged with identifying the habitat factors limiting the production of salmonids throughout most of the state. This information should guide lead entity groups and the Salmon Recovery Funding Board in prioritizing salmonid habitat restoration and protection projects seeking state and federal funds. Identifying habitat limiting factors requires a set of standards that can be used to compare the significance of different factors and consistently evaluate habitat conditions in each WRIA throughout the state.

In order to develop a set of standards to rate salmonid habitat conditions, several tribal, state, and federal documents that use some type of habitat rating system (Table 1) were reviewed. The goal was to identify appropriate rating standards for as many types of habitat limiting factors as possible, with an emphasis on those that could be applied to readily available data. Based on the review, it was decided to rate habitat conditions into three categories: Good, Fair, and Poor. For habitat factors that had wide agreement on how to rate habitat condition, the accepted standard was adopted by the WCC. For factors that had a range of standards, one or more of them were adopted. Where no standard could be found, a default rating standard was developed by WCC, with the expectation that it will be modified or replaced as better data become available.

Table 4. Salmonid Habitat Rating Criteria Source Documents.

Code	Document	Organization
Hood Canal	Hood Canal/Eastern Strait of Juan de Fuca Summer Chum Habitat Recovery Plan, Final Draft (1999)	Point No Point Treaty Council, Skokomish Tribe, Port Gamble S'Klallam Tribe, Jamestown S'Klallam Tribe, and Washington Department of Fish and Wildlife
ManTech	An Ecosystem Approach to Salmonid Conservation, vol. 1 (1995)	ManTech Environmental Research Services for the National Marine Fisheries Service, the US Environmental Protection Agency, and the US Fish and Wildlife Service
NMFS	Coastal Salmon Conservation: Working Guidance for Comprehensive Salmon Restoration Initiatives on the Pacific Coast (1996)	National Marine Fisheries Service
PHS	Priority Habitat Management Recommendations: Riparian (1995)	Washington Department of Fish and Wildlife
Skagit	Skagit Watershed Council Habitat Protection and Restoration Strategy (1998)	Skagit Watershed Council
WSA	Watershed Analysis Manual, v4.0 (1997)	Washington Forest Practices Board
USFWS Guidelines	A Framework to Assist in Making Endangered Species Act Determinations of Effect for Individual or Grouped Actions at the Bull Trout Subpopulation Watershed Scale	Fish and Wildlife Service
NMFS Criteria	Juvenile Fish Screen Criteria and the Addendum for Juvenile Fish Screen Criteria for Pump Intakes.	National Marine Fisheries Service
TAG 2000	The assessment of conditions are based on the professional knowledge and judgment of the Technical Advisory Group.	2496 Walla Walla Habitat Limiting Factors Technical Advisory Group (See Acknowledgements)
WSP	Wild Salmonid Policy (1997)	Washington Department of Fish and Wildlife

The ratings adopted by the WCC are presented in Table 5. These ratings are not intended to be used as thresholds for regulatory purposes, but as a coarse screen to identify the most significant habitat limiting factors in a WRIA. They will provide a level of consistency between WRIAs that allows habitat conditions to be compared across the state. However, where data are unavailable or where analysis of data have not been conducted, the professional expertise of the TAG is used. In some cases there may be local conditions that warrant deviation from the rating standards presented here. Additional rating standards will be included as they become available and will supercede the standards used in this report.

Table 5. WCC Salmonid Habitat Condition Rating Criteria.

Habitat Factor	Parameter/Unit	Channel Type	Poor	Fair	Good	Source
Fish Passage	Man-made physical barriers (address subsurface flows or dewatering where they impede fish passage under water quantity attributes)	All SE Washington	Man-made barriers present in the reach restrict upstream and/or downstream fish passage at a range of flows.	Man-made barriers present in the reach restrict upstream and/or downstream fish passage at base/low flows.	Man-made barriers present in the reach allow adequate upstream and downstream fish passage at all flows.	USFWS Guidelines TAG 2000
Screens and Water Diversion Ditches	Water diversions structures, both gravity and pump	All SE Washington	Does not meet NMFS juvenile fish screens criteria.	Meets all NMFS criteria for juvenile fish screens except screen mesh size.	Meets NMFS juvenile fish screen criteria.	NMFS Juvenile Fish Screen Criteria and Addendum for Pump Intakes
Riparian Condition	Riparian corridors, wetlands, intermittent headwater streams, and other areas where proper ecological functioning is crucial to maintenance of the stream's water, sediment, woody debris and nutrient delivery systems (definition taken from PACFISH for riparian habitat conservation areas – see glossary)	All SE Washington	riparian areas are fragmented, poorly connected, or provide inadequate protection of habitats for sensitive aquatic species (<70% intact, refugia does not occur), and do not adequately buffer landuse impacts; percent similarity of riparian vegetation to the potential natural community/composition is <25%.	moderate loss of connectivity or function (shade, LWD recruitment, etc.) of riparian areas, or incomplete protection of habitats and refugia for sensitive aquatic species (≈ 70-80% intact) and adequately buffer landuse impacts; percent similarity of riparian vegetation to the potential natural community/composition is 25-50% or better.	riparian areas provide adequate shade, LWD recruitment, and habitat protection and connectivity in subwatersheds, and buffers or includes known refugia for sensitive aquatic species (>80% intact) and adequately buffer landuse impacts; percent similarity of riparian vegetation to the potential natural community/composition is >50%.	USFWS Guidelines TAG 2000

Table 5. Continued.

Habitat Factor	Parameter/Unit	Channel Type	Poor	Fair	Good	Source
Streambank Condition	% of stream reach in stable natural condition	All SE Washington	<50% of any stream reach has ≥90% natural stability	50–80% of any stream reach has ≥90% natural stability	>80% of any stream reach has ≥90% natural stability	USFWS Guidelines TAG 2000
Floodplain Connectivity	Stream and off-channel habitat length with lost floodplain connectivity due to incision, roads, dikes, flood protection, or other	All SE Washington	Severe reduction in hydrologic connectivity between off-channel, wetland, floodplain and riparian areas; wetlands extent drastically reduced and riparian vegetation/succession altered significantly.	Reduced linkage of wetland, floodplains and riparian areas to main channel; overbank flows are reduced relative to historic frequency, as evidenced by moderate degradation of wetland function and riparian vegetation/succession.	Off-channel areas are frequently hydrologically linked to main channel; overbank flows occur and maintain wetland functions, riparian vegetation and succession.	USFWS Guidelines
Width/Depth Ratio	Ratio of Bankfull width to average bankfull depth (i.e. width divided by depth)	All SE Washington	>20 (example: 20' wide by 1' deep)	11-20 (example: 30' wide by 2' deep)	≤10 (example: 50' wide by 10' deep)	USFWS Guidelines TAG 2000
Substrate Embeddedness	Degree of substrate embeddedness in spawning and rearing areas	All SE Washington	>30%	20 – 30%	<20%	USFWS Guidelines TAG 2000
Large Woody Debris	Pieces/mile that are >12" in diameter and >35 ft. in length or stable at flows < 25 year event; also adequate sources of woody debris are available for both long and short-term recruitment within the channel migration zone (CMZ)	All SE Washington	Current levels are not at those desired values for "Good/Properly Functioning", and potential sources of woody debris for short and /or long term recruitment are lacking within the channel migration zone	Current values are being maintained at minimum levels desired for "Good/Functioning Appropriately", but potential sources for long-term woody debris recruitment are lacking within the channel migration zone to maintain these minimum values	Current values are being maintained at greater than 20 pieces/mile, >12" in diameter and >35 ft. in length or stable at flows < 25 year event; also adequate sources of woody debris are available for both long and short-term recruitment within the channel migration zone (CMZ)	USFWS Guidelines TAG 2000

Table 5. Continued.

Habitat Factor	Parameter/Unit	Channel Type	Poor	Fair	Good	Source
Pool Frequency	% wetted channel surface area comprising pools	All SE Washington	<20% surface area **or** Pools/mile equals:	20-40% surface area **or** Pools/mile equals:	>40% surface area **or** Pools/mile equals:	TAG 2000 PFC Working Group
		Wetted Width (ft)				
		0 to 5	<19.5	19.5 to 38	39	
		5 to 10	<30	30 to 59	60	
		10 to 15	<24	24 to 47	48	
		15 to 20	<19.5	19.5 to 38	39	
		20 to 30	<11.5	11.5 to 22	23	
		30 to 35	<9	9 to 17	18	
		35 to 40	<5	5 to 9	10	
		40 to 65	<4.5	4.5 to 8	9	
		65 to 100	<2	2 to 3	4	
Pool Quality	Majority of pools	All SE Washington	< 1' deep or little or no cover and lack of interstitial spaces	1-3' with some cover and some interstitial spaces	>3' deep and or with lots of surface or subsurface cover	TAG 2000
Off-channel Habitat	Area within the channel migration zone.	Reaches with average gradient <2% in SE Washington	Reach has no ponds, oxbows, backwaters, or other off-channel areas	Reach has <5 ponds, oxbows, backwaters, and other off-channel areas with cover per mile; but side-channel areas are generally high energy areas	Reach has >5 ponds, oxbows, backwaters, and other off-channel areas with cover per mile; and side-channels are low energy areas	USFWS Guidelines TAG 2000

Table 5. Continued.

Habitat Factor	Parameter/Unit	Channel Type	Poor	Fair	Good	Source
Temperature	degrees Celsius/ degrees Fahrenheit	All SE Washington	>15.6°C/ 60°F (spawning) or >21.1°C/ 70°F (migration and rearing) or For bull trout, 7-day average maximum temperature in a reach during the following life history stages: • >15°C/ 59°F (rearing) • <4°C or > 10°C/ <39°F or >50°F (spawning) • <1°C or >6°C/ 34°F or 43ºF (incubation) also temperatures in areas used by adults during migration regularly exceed 15ºC (59ºF) (thermal barriers present)	14-15.6°C/59-60°F (spawning) or 18.3-21.1°C/65-70°F (migration and rearing) or For bull trout, 7-day average maximum temperature in a reach during the following life history stages: • <4°C or >13-15ºC/ <39°F or >55º-59ºF (rearing) • <4°C or >10°C/ <39°F or 50°F (spawning) • <2°C or >6°C/ 36°F or 43ºF (incubation) also temperatures in areas used by adults during migration sometimes exceed 15ºC (59ºF)	10-14°C/50-59°F (spawning) or <21.1°C/65°F (migration and rearing) For bull trout, 7-day average maximum temperature in a reach during the following life history stages: • 4°-12ºC/ 39°-54ºF (rearing) • 4° - 9ºC/ 39°-48°F (spawning) • 2°-5°C/ 36°-41ºF (incubation) also temperatures do not exceed 15ºC (59ºF) in areas used by adults during migration (no thermal barriers)	NMFS and USFWS Guidelines TAG 2000
Water Quantity/ Dewatering	presence/absence in a stream reach	All SE Washington	No flows during some portion of the year or inadequate for all lifestages	Inadequate flows for some lifestages during some portion of the year	Adequate flows for all lifestages present year-round	TAG 2000

Table 5. Continued.

Habitat Factor	Parameter/Unit	Channel Type	Poor	Fair	Good	Source
Change in Flow Regime	Change in Peak/Base Flows	All SE Washington	pronounced changes in peak flow, base flow and/or flow timing relative to an undisturbed watershed of similar size, geology and geography	some evidence of altered peak flow, base flow and/or flow timing relative to an undisturbed watershed of similar size, geology and geography	watershed hydrograph indicates peak flow, base flow and flow timing characteristics comparable to an undisturbed watershed of similar size, geology and geography	USFWS Guidelines
Biological Processes	Lack of nutrient input from spawners, exotic species, etc…	All SE Washington	No anadromous carcasses and there is likely exotic species competition	Few anadromous carcasses or there is exotic species competition	Many anadromous carcasses and no exotic species	TAG 2000

SALMONID HABITAT ASSESSMENT BY STREAM REACH

The narrative descriptions for each of the five subbasins discussed earlier in this report were compared to the rating criteria found in Table 5 to assess salmonid habitat conditions across the Walla Walla Watershed. Each reach discussed in the report has a corresponding assessment in Table 6. A key to table abbreviations is found at the end of the assessment table. Unless proven otherwise, screens and diversions were rated POOR on every reach because of the estimated 90% non-compliance rate with juvenile fish screening requirements. See **Landuse and Salmonid Habitat Conditions**. Biological processes received a maximum rating of FAIR because of a nearly uniform lack of anadromous fish carcasses and depressed beaver populations throughout the watershed. Ratings in the "Water Quality/Temperature" column are based on water temperatures only. Very little information is available on other water quality issues such as chemical pollution, sewage effluent, dissolved oxygen levels, etc. Reaches that received a poor rating are identified as habitat limiting factors in Table 7. This table also attempts to identify probable causes for the poor habitat conditions.

Table 6. Salmonid Habitat Assessment by Stream Reach.

Key:

P = Average habitat condition considered poor (Not Properly Functioning)

F = Average habitat condition considered fair (At Risk)

G = Average habitat condition considered good (Properly Functioning)

1= Quantitative studies or published reports documenting habitat condition

2 = Professional knowledge of the WRIA 32 TAG members

S = Suspected

DG = Data Gap: habitat on the stream or reach has not been evaluated, TAG members had little or no knowledge of habitat conditions. The parameter was not rated.

NB = Natural Barrier

NAT = Natural

N/A = Not Applicable

N/E = Not Evaluated

= Bull trout juvenile (fry) rearing temperatures used for assessment

Stream Name	Fish Passage	Screens & Diversions	Riparian Condition	Streambank Condition	Floodplain Connectivity	Width/ Depth Ratio	Substrate Embed.	LWD	Pool Freq.	Pool Qual.	Off-channel Habitat	Water Quality/ Temperature	Water Quantity/ Dewatering	Change in Flow Regime	Biological Processes
Upper Touchet Subbasin															
N.F. Touchet: Headwaters to Lewis Crk.	F2	P2	F1,2	F1	F1,2	F1	F1	F1	P1	P1	F1	G1	G2	G2	F2
N.F. Touchet: Lewis Creek to Wolf Fork	F1,2	P2	P1	F1	P2	P1	F2	P1	P1	F1	P2	P1	F2	F2	P1,2
N.F. Touchet/ Touchet: Wolf Fork to L/C Trail State Park	F1	P2	P2	P1,2	P1,2	P1	G2	P2	P1	F1,2	P1,2	P1	F2	F2	P1,2
Wolf Fork: Headwaters to Whitney Crk.	P2	N/A	F2	G2	F1,2	G2	F2	P1,2	P1	F1	P2	G1	G2	F2	F2
Wolf Fork: Whitney Crk. Downstream	G2	P2	P1,2	P1-F1	F2	P1,2	P1	P1,2	P1	P1	P1	G1	F2	F2	P1,2
Robinson Fork	G2	N/A	P1,2	P1	P2	P2	SP1	F1	F1	P1-F1	P1	F1	P2	P1,2	F2
S.F. Touchet: Griffin Fork to mouth	G2	P2	P1	P1	P1	P1	P1	P1	P1	P1	P1	P1	P2	P2	P1,2
S.F. Touchet: Griffin, Burnt, Green Forks	G1	N/A	P1	F2-G1	P1	F1,2	DG	P1,2	P1	P1	N/A	DG	G1,2	P1	F2

Table 6. Continued.

Stream Name	Fish Passage	Screens & Diversions	Riparian Condition	Streambank Condition	Floodplain Connectivity	Width/ Depth Ratio	Substrate Embed.	LWD	Pool Freq.	Pool Qual.	Off-channel Habitat	Water Quality/ Temperature	Water Quantity/ Dewatering	Change in Flow Regime	Biological Processes
Lower Touchet Subbasin															
Touchet: L/C Trail State Park to Coppei Creek	F1,2	P2	P1	P2	P1,2	DG	SF2	P1	SP2	F1	P2	P1	F2	F2	P1,2
Touchet: Coppei Creek to Hwy. 125	G2	P2	P1	P1,2	P1,2	DG	P2	F1	G1	F1	P2	P1	F2	F2	P1,2
Coppei Creek	F1,2	P2	F1,2	F1,2	P1,2	DG	P1	P1,2	P1	DG	P1	F1	F1	F2	F2
Touchet: Hwy. 125 to mouth	P1	P2	P2	DG	P2	DG	P2	P2	SG2	P2	P2	P1	P1	P1	P1,2
Lower Walla Walla Subbasin															
Walla Walla: Stateline to Mill Creek	F1,2	P2	P2	P2	P2	DG	P2	P2	DG	DG	P2	P1	P1,2	P1,2	F2
Walla Walla: Mill Creek to McDonald Rd.	F1,2	P2	P2	P2	P2	DG	F2	P2	SP2	F1	P2	P1	F2	P1,2	P1,2
Walla Walla: McDonald Rd. to mouth	F2	P2	F1	P1,2	P2	DG	P1,2	P2	F1	P1	F2	P1	F1,2	P1,2	P1,2
Pine & Mud Creeks	SF2	P2	P2	P1	P1	SG1	P2	SP2	SG2	DG	SP1	P1	P2	P2	SF2
Dry Creek: Headwaters to Hwy. 12 at Smith Rd.	P1	P2	F2	G1	F2	DG	SP1,2	P1	F1	F1	DG	F1	F2	F2	F2
Dry Creek: Hwy. 12 at Smith Rd. to mouth	F2	P2	P2	P1	P1	DG	P2	P2	DG	DG	P2	P1	F2	F2	P2

Table 6. Continued.

Stream Name	Fish Passage	Screens & Diversions	Riparian Condition	Streambank Condition	Floodplain Connectivity	Width/ Depth Ratio	Substrate Embed.	LWD	Pool Freq.	Pool Qual.	Off-channel Habitat	Water Quality/ Temperature	Water Quantity/ Dewatering	Change in Flow Regime	Biological Processes
Mill Creek: Bennington Lake Dam to mouth	P1	P2	P1,2	P1	P1	P2	P2	P2	P2	P2	P1	P1	P1	P1	P2
Garrison Creek	P1,2	P2	P2	DG	P2	G2	P2	P2	DG	DG	P2	P1	P2	P2	F2
Yellowhawk Creek	P1	P2	F2	P1	P2	G2	P2	P1	P1	F1	P2	P1	G1,2	P2	F2
Cottonwood, Russell, & Reser Creeks	P2	P2	P2	SP2	SF2-SP2	P2-F2	DG	DG	DG	DG	DG	P1	P2	P2	F2
Upper Mill Creek Subbasin															
Mill Creek: Headwaters to Bennington Lake Dam	P1,2	P2	F1-G1	F1-G1	F1,2	F1,2	G1	P1	P1	F1	G1,2	F1-G1	P1,2	P1,2	F2
Mill Creek Tribs. (USFS)	G1	N/A	G1	G1	G1	F1	F1	G1	P1	P1-F1	G1	G1	G1	G1	F2
Oregon Walla Walla Subbasin															
Walla Walla: Forks to Stateline	F1	N/E	P1	P1	P1	P1	N/E	P1,2	N/E	N/E	P1	N/E	P1	P1	F2
N.F. Walla Walla (USFS)	G1	N/A	G1	DG	G1	F1	DG	G1	G1	P1	DG	SG2	G1	G1	F2
S.F. Walla Walla (USFS)	G1	N/A	G1	DG	G1	P1	DG	G1	F1	F1	DG	G2	G1	G1	F2
S.F. Walla Walla Tribs. (USFS)	G1	N/A	F1	DG	N/A	F1	P1-F1	P1-F1	P1	P1-F1	N/A	SG2	G1	G1	F2

HABITAT LIMITING FACTORS, POTENTIAL CAUSES, AND RECOMMENDATIONS

Reaches that received a poor rating in Table 6 are identified as habitat limiting factors in Table 7 . This table also attempts to identify probable causes for the poor habitat conditions. Prioritized recommendations to improve habitat conditions are included as well.

Table 7. Habitat Limiting Factors, Potential Causes, and Recommendations

Habitat Limiting Factor	**Stream Reach (Rated Poor in Table 6)**	**Potential Human-Induced Causes (In order of significance)**	**Recommendations (In order of priority)**
Fish Passage	1, 2, 4a, 16, 18-22	Diversion Dams (concrete and gravel push-ups) Grade control structures Failed culverts Road Fords	1. Install fish passage structures 2. Replace failed culverts 3. Replace push-up dams with structures that provide passage 4. Replace fords with bridges, or decommission
Screens & Diversions	ALL	Unscreened Diversions Existing screens do not meet NMFS criteria	1. Conduct comprehensive basin-wide inventory of surface water diversions to ensure that all diversions are properly screened and implement corrective measures
Riparian Condition	2-13, 15, 17-21, 24	Conversion to cropland Residential development Grazing Logging	1. Enforce land use regulations 2. Fence livestock out of riparian zones 3. Replant native riparian vegetation
Bank Condition	3, 6, 8, 12, 14, 15, 17, 18, 20, 21, 24	Removal of riparian vegetation Channel modifications including: dikes, riprap, bridges, channel relocation, and culverts	1. Remove or setback dikes, remove riprap 2. Restore meandering channel geometry 3. Replant native riparian vegetation
Floodplain Connectivity	2, 3, 8-12, 14, 15, 17-21, 24	Construction of dikes and levees Channel modifications including: straightening and riprap Conversion of wetlands to cropland	1. Enforce land use regulations 2. Remove or setback dikes, remove riprap 3. Restore meandering channel geometry
Width/Depth Ratio	2-6, 18, 21, 24, 26	Unstable streambed and banks caused by removal of riparian vegetation and channel modifications	1. Restore meandering channel geometry 2. Replant native riparian vegetation
Substrate Embeddedness	4b-6, 8, 9, 11, 12, 14, 15, 17-20, 27	Fine sediment eroded from croplands and roads Fine sediment eroded from forest lands and roads Fine sediment eroded from unstable banks	1. Convert from conventional tillage to no-till farming methods 2. Decommission dirt roads 3. Replant native riparian vegetation
Large Woody Debris	2-4a & b ,6-8, 10-18, 20, 22, 24, 27	Removal of wood from stream channels Removal of large trees in riparian zone Dikes and levees restrict access to riparian vegetation	1. Place LWD in spawning are rearing reaches 2. Restore meandering channels 3. Leave LWD in channels and replant native riparian vegetation
Pool Frequency	1, 2, 4a & b, 6-8, 10, 13, 18, 20, 22, 23, 27	Lack of large woody debris Channel modifications including: dikes, riprap, bridges, channel relocation and culverts	1. Place LWD in spawning and rearing reaches 2. Restore meandering channel geometry 3. Leave LWD in channels and replant native riparian vegetation
Pool Quality	1, 4b-7, 18, 23, 25, 27	Lack of large woody debris Channel modifications including: dikes, riprap, bridges, channel relocation and culverts	1. Place LWD in spawning and rearing reaches 2. Restore meandering channel geometry 3. Leave LWD in channels and replant native riparian vegetation
Off-channel Habitat	2-4a & b, 6, 8-12, 15, 17-20, 24	Construction of dikes and levees Channel modifications including: channel modification, riprap Conversion of wetlands to cropland	1. Enforce land use regulations 2. Remove or setback dikes, remove riprap 3. Replant native riparian vegetation
Water Quality/ Temperature	2, 3, 5, 8, 9, 11, 13-15, 18, 19, 21	Naturally low summer stream flows exacerbated by irrigation water withdrawals and high air temperatures Lack of riparian vegetation to provide shade	1. Increase summer instream flows 2. Replant native riparian vegetation

Table 7. Continued.

Habitat Limiting Factor	Stream Reach (Rated Poor in Table 6)	Potential Human-Induced Causes (In order of significance)	Recommendations (In order of priority)
Water Quantity/ Dewatering	5, 6, 11, 12, 15, 18, 19, 21, 22, 24	Naturally low summer stream flows exacerbated by irrigation water withdrawals and high air temperatures	1. Increase summer instream flows 2. Restore floodplain connectivity 3. Reduce surface water losses on losing reaches
Change in Flow Regime	2-4b, 6, 8, 9, 11, 13, 14, 16-18	Surface water withdrawals, logging, channel modifications, agriculture, urban development	1. 1.Increase summer instream flows 2. Restore meandering channel geometry 3. Reduce impervious surfaces and increase perennial vegetation
Biological Processes	6, 7, 11, 12-15, 18-22, 24	Introductions of exotic plants and animals, extinction of native spring chinook, trapping of beaver	1. Eradicate exotic fish and riparian plant species 2. Seed upper watersheds with hatchery carcasses or reintroduce spring chinook 3. Allow beaver populations to rebuild

Key to Reach Numbers:

1. N.F. Touchet: Source to Lewis Creek
2. N.F. Touchet: Lewis Creek to Wolf Fork
3. N.F. Touchet/ Touchet: Wolf Fork to L/C Trail State Park
4. (a) Wolf Fork: Headwaters to Whitney Creek
   (b) Wolf Fork: Whitney Creek downstream
5. Robinson Fork
6. S.F. Touchet: Griffin Fork to mouth
7. S.F. Touchet: Griffin, Burnt, Green Forks
8. Touchet: L/C Trail State Park to Coppei Creek
9. Touchet: Coppei Creek to Hwy. 125
10. Coppei Creek
11. Touchet: Hwy. 125 to mouth
12. Walla Walla: Stateline to Mill Creek
13. Walla Walla: Mill Creek to McDonald Rd.
14. Walla Walla: McDonald Rd. to mouth
15. Pine & Mud Creeks
16. Dry Creek: Source to Hwy. 12 at Smith Rd.
17. Dry Creek: Hwy. 12 at Smith Rd. to mouth
18. Mill Creek: Bennington Lake Dam to mouth
19. Garrison Creek
20. Yellowhawk Creek
21. Cottonwood, Russell, & Reser Creeks
22. Mill Creek: Source to Bennington Lake Dam
23. Mill Creek Tribs. (USFS)
24. Walla Walla: Forks to Stateline
25. N.F. Walla Walla (USFS)
26. S.F. Walla Walla (USFS)
27. S.F. Walla Walla Tribs. (USFS)

CURRENT SALMONID HABITAT RESTORATION EFFORTS AND RECOMMENDATIONS FOR FURTHER ACTION

Current Salmonid Habitat Restoration Efforts

Soil Erosion

The "Habitat Limiting Factors by Subbasin" narratives paint a rather grim picture of salmonid habitat conditions in the Walla Walla Basin, but efforts are currently under way to address many of the issues identified above. The conservation districts of Walla Walla and Columbia Counties in cooperation with the USDA Natural Resources Conservation Service (NRCS) and Washington State University Cooperative Extension (WSU Extension) are working to encourage dryland farmers to implement best management practices (BMPs) that reduce soil erosion (Tillage bar chart). These practices include no-till farming methods (direct seeding into standing wheat stubble for example); installation of terraces, sediment basins, and vegetated filter strips; and enrollment of acreage in the Conservation Reserve Program (CRP, conversion of annual cropland to perennial grass stands for wildlife habitat benefits). Currently no-till farming methods are utilized on 9% of Walla Walla County's 422,141 total cropped acres (Pie chart) and 25% of Columbia County's 145,587 total cropped acres (Pie chart) (Hooker, L. 2000 Personal Communication, Schlenz, G. 2000 Personal Communication).

These efforts are important, but considerable additional progress toward erosion reduction is needed, especially in the Touchet, Dry Creek, and Coppei Creek watersheds of Walla Walla County. These streams carry extremely high sediment loads following storm events in summer, fall, and winter. Conversion from conventional tillage to no-till farming methods requires more than a change in management practices. It often requires substantial investments of capital in new equipment. Many producers are reluctant to make the transition because of cost and skepticism about the economic viability of no-till farming methods. Efforts should continue to educate producers about the costs and benefits of no-till farming along with financial assistance programs that lessen the cost of conversion.

Riparian Buffers

The Conservation Districts and NRCS are addressing riparian zone problems with the Conservation Reserve Enhancement Program (CREP). The program is intended to restore riparian forest buffers on agricultural lands adjacent to salmon bearing streams. Livestock is fenced out of the buffer and native vegetation is planted. Landowners are compensated at 200% of the agricultural value of the land placed in the buffer over a 10 to 15-year rental agreement. All plant materials, fencing, and alternate livestock watering facilities are paid for by the program. Currently Walla Walla County has implemented approximately 9.7 miles of riparian buffers, with 10 additional miles planned for 2001 (Smith, L. 2000 Personal Communication). Columbia County Conservation District has initiated CREP contracts on the following streams: Wolf and Robinson Forks (3 contracts, 87.1 acres), Patit Creek (2 contracts, 94.1 acres), and the Touchet River (1 contract, 6.5 acres) (Nordheim, D. 2000 Personal Communication). The Confederated

Tribes of the Umatilla Indian Reservation (CTUIR) has replanted and fenced riparian buffers along the South Fork Patit Creek and Blue Creek with funding from the Bonneville Power Administration (BPA) (Mendel, G. 2001 Personal Communication)

A mature riparian forest does not spring up overnight, making restoration and realization of the associated benefits a long term process. Dry summers, incised stream channels, low water tables, and weed competition will likely make riparian restoration difficult. Supplemental watering of young vegetation will be necessary. Where possible landowners with water rights to irrigate crops on the land converted to riparian buffer should be encouraged to utilize the water right to irrigate the buffer. In essence the landowner is being paid to grow a riparian buffer rather than an irrigated crop such as alfalfa, therefore they should make every effort to ensure that the crop (i.e., riparian vegetation) flourishes. Some stream reaches presently exhibit very unstable stream channels (example: the South Fork Touchet River). In these areas some instream work (bioengineering) will likely be needed to stabilize banks long enough to prevent channel migration that will destroy young plantings. However, this should not be used as a justification to armor banks for flood control purposes under the guise of salmon habitat restoration.

The WRIA 32 technical advisory group (TAG) has recommended that riparian restoration projects be targeted as far upstream as possible. This will provide the most benefit by keeping water cool and conveying it downstream, rather than attempting to cool water onsite after temperatures have exceeded the tolerance level of salmonids. This philosophy is especially important when project funding is obtained through a competitive process such as Salmon Recovery Funding Board (SRFB) monies. Ideally BPA and CREP funded projects should be targeted with this strategy as well, but if eligible land and willing landowners are not present in the upper reaches of a stream, riparian buffers should be implemented where possible downstream.

Instream Habitat

Many streams in the Walla Walla Basin lack channel complexity in the form of pools and instream cover, including large woody debris (LWD) and large rocks. The conservation districts (CDs) have begun addressing this issue. Walla Walla CD has installed 195 pieces of LWD, 64 log and rock structures, five woody debris jams, six boulder clusters, and seven off-channel habitat areas in Walla Walla County streams. They also constructed one set back levee to reestablish floodplain connectivity (Smith, L. 2000 Personal Communication). Columbia CD has implemented 4 projects on the Touchet mainstem between Dayton and the west county line. These projects included 18 structures and 53 large woody debris structures (Structures include: vortex weirs, J-hook vanes, log vanes, sills, and random boulder clusters. LWD includes: revetments, random log placement, and random log clusters). Other projects completed by Columbia CD include: Touchet River from Dayton to U.S. Forest Service Boundary (5 projects: 11 structures, and 127 LWD structures), South Fork Touchet River (projects 2: 5 structures, 84 LWD structures), Wolf and Robinson Forks (1 project: 50 LWD structures) (Nordheim, D. 2000 Personal Communication). Instream projects have their place, but the TAG has recommended that salmon habitat restoration efforts concentrate on removing/retrofitting barriers to salmonid migration and restoring/preserving ecological processes (i.e., functional riparian zones and restoring access to useable habitat). Ideally these projects will be large in size and of long duration. However, instream structures may be a beneficial component of a large scale riparian restoration or barrier removal project.

Adult Fish Passage

The BPA, CTUIR, USACE, and irrigation districts have made major adult fish passage improvements at Burlingame Dam and Nursery Bridge Dam. Additional efforts are planned throughout the Basin. See Table 8.

Walla Walla Watershed Technical Workgroup (TWG)

The Technical Workgroup is composed of resource professionals, irrigation districts, and citizens from both the Washington and Oregon portions of the Walla Walla Basin. It was created to encourage coordination between groups throughout the basin. Personnel from the following agencies contribute to the group: Conservation Districts (from Columbia, Walla Walla, and Umatilla Counties), Washington Department of Fish and Wildlife, Washington Department of Ecology, Oregon Department of Fish and Wildlife, Oregon Water Resources Department, Oregon Department of Environmental Quality, Confederated Tribes of the Umatilla Indian Reservation, U.S. Fish and Wildlife Service, irrigation districts (Gardena Farms, Walla Walla River, Hudson's Bay Improvement), Walla Walla Watershed Council, U.S Army Corps of Engineers, and others.

Nursery Bridge Dam Cooperative Fish Rescue

A 1936 U.S. Supreme Court Case (George G. Hannan *et al.* 1931) gave Oregon irrigators the legal right to divert the entire flow of the Walla Walla River prior to its entry to Washington. Diversion of the entire flow at Nursery Bridge Dam near Milton-Freewater, Oregon occurred annually each year until the summer of 2000 when a civil penalty agreement reached between the three largest irrigation districts (Walla Walla River, Hudson's Bay Improvement, and Gardena Farms) and the U.S. Fish Wildlife Service required that 13 cfs be passed over the dam (Durfee, S. 2000 Personal Communication). Dewatering of the channel below Nursery Bridge Dam routinely left several thousand juvenile steelhead/rainbow/redband trout, along with a few juvenile bull trout and whitefish stranded in pools. A cooperative rescue effort between the Oregon Department of Fish and Wildlife, Confederated Tribes of the Umatilla Indian Reservation, and occasionally the Washington Department Fish and Wildlife has been undertaken for several years. The fish were captured and transported via tanker truck to reaches with suitable habitat. Personnel from the three major irrigation districts named above helped with the effort in the year 2000 (Germond, J. 2000b Personal Communication).

Surface Water Diversion Screens

Improperly screened or unscreened irrigation diversions are a major limiting factor of salmonid production in the Walla Walla Watershed. The Washington Department of Fish and Wildlife is currently conducting a trial run of a program known as the Cooperative Compliance Review Program. This program invites irrigators to voluntarily step forward and request technical and financial assistance for diversion improvements without fear of enforcement action. The program provides funding for 85% of the cost of equipment upgrades to bring diversions into compliance with National Marine Fisheries Service (NMFS) juvenile fish screening criteria. Current compliance with NMFS screening criteria has been estimated at 10% for the entire Walla Walla Basin. As of December 2000, 417 diversions have been identified for inclusion in the program (Bireley 2000). Significant screening improvement efforts led by the CTUIR, Walla Walla Watershed Council (Oregon), and U.S. Army Corps of Engineers have been implemented throughout the Basin. See Table 8.

Potential Future Sources of Information

The following studies and reports were in various stages of development at the time of completion of this report. The results of the efforts below may potentially shed some light on several data gaps identified during development of the WRIA 32 salmonid habitat limiting factors report.

- Walla Walla Stream Classification: This project is headed by the Oregon Department of Environmental Quality. Approximately 25 transects were walked at points along the Walla Walla River from the mouth to the forks. The stream was classified by the Rosgen method. Pebble counts, channel measurements, and riparian descriptions were included in the assessment.

- Walla Walla/ Umatilla Bull Trout Recovery Plan: This document will describe the status of bull trout populations within the Walla Walla and Umatilla basins. Oregon Department of Fish and Wildlife is coordinating this effort for the U.S. Fish and Wildlife Service.

- Forward Looking Infrared Reconnaissance (FLIR): Infrared photography was utilized to photograph the Walla Walla River from the forks to the mouth during summer of 2000. These photographs will likely identify thermal barriers in the stream.

- Instream Flow Incremental Methodology (IFIM): Currently being conducted by WDFW and the USACE on the Washington portion of the Walla Walla River and the Touchet River. The data obtained from these studies should be valuable in addressing instream flow issues.

- BPA funded assessment of salmonid populations and habitat conditions in the Walla Walla basin being conducted by WDFW for one or more years until completed.

Table 8. Salmonid Habitat Improvement Projects in the Walla Walla Basin. Source: Saul *et al.* 2001.

Key:
CCD: Columbia Conservation District
CTUIR: Confederated Tribes of the Umatilla Indian Reservation
HBID: Hudson's Bay Improvement District
IAC: Inter Agency Committee for Outdoor Recreation
NMFS: National Marine Fisheries Service
NPS: National Park Service
NRCS: Natural Resource Conservation Service
ODFW: Oregon Department of Fish and Wildlife
OWEB: Oregon Watershed Enhancement Board
OWRD: Oregon Water Resources Department
SRFB: Salmon Recovery Funding Board (Washington)
UC: Umatilla County
USACE: U.S. Army Corps of Engineers
USBR: U.S. Bureau of Reclamation
WDFW: Washington Department of Fish and Wildlife
WDOE: Washington Department of Ecology
WDOT: Washington Department of Transportation
WWBWC: Walla Walla Basin Watershed Council
WWCD: Walla Walla Conservation District
WWID: Walla Walla Irrigation District

Project	Lead Agency	Funding Source	Status/Duration
Fish Passage			
Walla Walla River Fish Passage	CTUIR	BPA	2000-2004
Walla Walla River Juvenile Fish Passage	CTUIR	BPA	1997-2004
Adult Fish Passage in the Subbasin	CTUIR	BPA	1996-1999
Walla Walla, Touchet, and Mill Creek riparian habitat enhancement	WWCD	BPA	1996-1998
Couse Creek Riparian Enhancement	CTUIR	BPA	1996-1998
Walla Walla River Subbasin Watershed Improvement Project	CTUIR	BPA	
Juvenile Fish Screens in the Oregon portion of the Walla Walla River	ODFW	ODFW	2001
Fish Passage and Screening at the City of Walla Walla Water intake on Mill Creek	City of Walla Walla	OWEB, NMFS	2001
South Fork Walla Walla Adult Passage	OWEB, WWBWC, Private		Ongoing
North Fork Walla Walla Adult Passage	OWEB, WWBWC, Private		Ongoing
Adult Passage on Stone Creek	WDFW, WWCD		Complete
Adult Fish Passage on Mill Creek	WWCD	WDOT	Complete
Fish Passage and Screening on Mill Creek	WWCD	SRFB	Complete
Adult Passage at Touchet River Push-up Dams	CCD	IAC	Planning
Fish Passage and Screening at Bennington Lake Intake	WDFW, USACE	SRFB, USACE	Ongoing
Screen Retrofitting in Oregon	ODFW	Mitchell Act	Ongoing
Diversion Inventory and Screening in Washington	WDFW	SRFB	Ongoing
Adult Passage on South Fork Kibbler Creek	WWBWC	OWEB, CTUIR	Planning
Adult Passage on South Fork Hopper Creek	WWBWC	OWEB, CTUIR	Planning
Adult Passage on North Fork Sams Creek	WWBWC	OWEB, CTUIR	Planning
Adult Passage on North Fork Walla Walla River	WWBWC	OWEB, CTUIR	Planning

Table 8. Continued.

Project	Lead Agency	Funding Source	Status/Duration
Adult Passage on Bullock Creek	WWBWC	OWEB, CTUIR	Planning
Adult Passage at Lewis Creek Barrier	CCD, WDFW	SRFB	Planning
Adult Passage on South Fork Robertson Creek	WWBWC	OWEB, CTUIR	Planning
Adult Passage on Garrison Creek	City of College Place, USACE		Planning
Adult Passage at Gose Road, Mill Creek	USACE		Planning
Adult Passage at Carlson Creek	NRCS		Planning
Adult Passage at Whitman Mission, Doan Creek	NPS		Planning
Fish Passage and Screening at Eastside Nursery Pump, Walla Walla River	ODFW		Planning
Adult Passage at Fern and 9th Streets, Yellowhawk Creek	WWCD	SRFB	Planning
Adult Passage on Whiskey Creek	WDFW	SRFB	Ongoing
Adult Passage at Small Dams, Yellowhawk Creek	WWCD	SRFB	Ongoing
Adult Passage and Riparian Enhancement, Patit Creek	WDFW, Private	CCD	Ongoing
Headgate Installation	OWRD, UC, NRCS, OWEB, WWBWC		
Little Walla Walla Diversion Consolidation and Water Conservation	USBR, WWID, HBID, OWRD		
Screening on Lower Walla Walla River, Garrison Creek and Mill Creek	Walla Walla County	USACE	
Adult Passage Buroker Dam, Dry Creek (Oregon)			
Adult Passage Hudson's Bay Road, Pine Creek (Oregon)			
Adult Passage, Dry Creek (Washington)			
Adult Passage Reser Creek Dam			
Adult Passage Mud Creek Culvert			
Adult Passage, Pine Creek (Washington)			
Adult Passage Mill Creek			
Adult Passage Yost Ditch, Touchet River			
Adult Passage Hern Ditch, Touchet River			
Adult Passage Couse Creek			
Fish Passage and Screening in WRIA 32	WDFW		

Table 8. Continued.

Project	Lead Agency	Funding Source	Status/Duration
Flow Enhancement			
Irrigation Conservation	WWBWC	OWEB	
Water Allocation	WDOE, OWRD		
Streamflow Enhancement	WDOE, OR Water Trust, OWRD		
Filing Instream Water Rights	ODFW		
Acquire Water to Enhance Streamflows	OWRD		
Streamflow Enhancement	WA Water Trust		
Habitat Enhancement			
Rainwater Wildlife Area Watershed Restoration	CTUIR	Washington State	
Habitat Enhancement	CCD, WWCD		1997-ongoing
Couse Creek/ Shumway Riparian and Instream Restoration	ODFW, NRCS, WWBWC, CTUIR		1996-2001
Columbia Co. Stream Habitat Enhancement	CCD	SRFB, Various	Ongoing
Upland Enhancement Via Direct Seeding (No-till Farming)	CCD	SRFB	Ongoing
Stream Enhancements	USACE	Milton-Freewater Water Control District	Ongoing
Patit Creek Habitat Enhancement	CTUIR	SRFB	Ongoing
South Fork Touchet Habitat Enhancement	CTUIR	SRFB	Ongoing
Habitat Protection Basin-wide	CTUIR		Ongoing
Stream Habitat Enhancement Basin-wide	CCD, WWCD		Ongoing
Fish and Habitat Management Planning for Habitat Conservation Plan	Irrigation Districts		Ongoing
Flood Control District Planning for Buffers	City of Prescott		Ongoing
Stone Creek Habitat Enhancement	Wal-Mart		Ongoing
Upland Restoration Plantings	WDFW		Ongoing
Direct Seeding	WWCD		Ongoing
Yellowhawk Creek Riparian Enhancement	WDFW	Private	Ongoing
Mill Creek Flood Control Project Enhancements	USACE		Planning
Garrison Creek Habitat Enhancement	USACE		Planning
College Place Sewage Treatment Plant Stream Habitat Enhancement, Garrison Creek	City of College Place, WWCD, Walla Walla County		Planning
Lower Mill Creek Habitat Enhancement	Tri-State Steelheaders		Planning
Construct 206 Setback Levees on Walla Walla River	USACE	Milton-Freewater Water Control District	Planning
Mill Creek/Titus Creek Levee Setback	USACE	Walla Walla County	

DATA GAPS

Data gaps are identified in Table 6. The only detailed habitat assessments available in this watershed are focused on USFS lands. No other entities have conducted systematic and detailed habitat inventories and assessments on private lands. Because of this, data gaps are most common on highly degraded reaches on private lands in the lower portions of the watershed. In-depth habitat assessments of these areas have been a relatively low priority because the reaches are of little use to salmonids. However there is enough information available to show that conditions on these reaches are unfavorable, but in many cases we do not know how severely the habitat has been degraded. With the exception of temperature, water quality data are lacking throughout the basin. Landuse patterns make it likely that fertilizer, herbicides, sewage effluent, and other pollutants are being discharged to streams in the watershed.

HABITAT TO PROTECT

The following reaches currently provide quality salmonid spawning and rearing habitat, or access to such areas. See Map 10 in Appendix B. The WRIA 32 Technical Advisory Group recommends maintaining or improving habitat functions on these reaches.

1. North Fork Touchet River from Lewis Creek upstream
2. Wolf Fork from Whitney Creek upstream
3. Mill Creek from Blue Creek upstream
4. Yellowhawk Creek
5. South Fork Coppei Creek from the North/South Fork confluence upstream
6. South Fork Walla Walla River from the confluence to the headwaters
7. North Fork Walla Walla River on USFS lands

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APPENDIX A: GLOSSARY

Adfluvial: Life history strategy in which adult fish spawn and juveniles subsequently rear in streams, but migrate to lakes for feeding as subadults and adults. Compare to *fluvial*.

Aggradation: The geologic process of filling and raising the level of the streambed or floodplain by deposition of material eroded and transported from other areas.

Anadromous fish: Species that are hatched in freshwater, mature in saltwater, and return to freshwater to spawn.

Aquifer: Water-bearing rock formation or other subsurface layer.

Basin: The area of land that drains water, sediment and dissolved materials to a common point along a stream channel.

Biological Diversity (biodiversity): Variety and variability among living organisms and the ecological complexes in which they occur; encompasses different ecosystems, species, and genes.

Biotic Integrity: Capability of supporting and maintaining a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of natural habitat of the region; a system's ability to generate and maintain adaptive biotic elements through natural evolutionary processes.

Braided stream: Stream that forms an interlacing network of branching and recombining channels separated by branch islands or channel bars.

Buffer: An area of intact vegetation maintained between human activities and a particular natural feature, such as a stream. The buffer reduces potential negative impacts by providing an area around the feature that is unaffected by this activity.

Carrying capacity: Maximum average number or biomass of organisms that can be sustained in a habitat over the long term. Usually refers to a particular species, but can be applied to more than one species.

Channelization: Straightening the meanders of a river; often accompanied by placing riprap or concrete along banks to stabilize the system.

Channelized stream: A stream that has been straightened, runs through pipes or revetments, or is otherwise artificially altered from its natural, meandering course.

Channel Stability: Tendency of a stream channel to remain within its existing location and alignment.

Check dams: Series of small dams placed in gullies or small streams in an effort to control erosion. Commonly built during the 1900s.

Confluence: Joining.

Connectivity: Unbroken linkages in a landscape, often referred to in the context of mainstem connection with side-channels.

Critical Stock: A stock of fish experiencing production levels so low that permanent damage to the stock is likely or has already occurred.

Depressed Stock: A stock of fish whose production is below expected levels based on available habitat and natural variations in survival levels, but above the level where permanent damage to the stock is likely.

Debris torrent: Rapid movements of material, including sediment and woody debris, within a stream channel. Debris torrents frequently begin as debris slides on adjacent hillslopes.

Degradation: The lowering of the streambed or widening of the stream channel by erosion. The breakdown and removal of soil, rock, and organic debris.

Deposition: The settlement of material out of the water column and onto the streambed or floodplain.

Distributaries: Divergent channels of a stream typically occurring in a delta or estuary.

Diversity: Variation that occurs in plant and animal taxa (i.e., species composition), habitats, or ecosystems. See *species richness.*

Ecological restoration: Involves replacing lost or damaged biological elements (populations, species) and reestablishing ecological processes (dispersal, succession) at historical rates.

Ecosystem: Biological community together with the chemical and physical environment with which it interacts.

Ecosystem management: Management that integrates ecological relationships with sociopolitical values toward the general goal of protecting or returning ecosystem integrity over the long term.

Endangered Species Act: A 1973 Act of Congress that mandated that endangered and threatened species of fish, wildlife, and plants be protected and restored.

Endangered Species: Means any species which is in endanger of extinction throughout all or a significant portion of its range other than a species of the Class Insecta as determined by the Secretary to constitute a pest whose protection under would provide an overwhelming and overriding risk to man.

Escapement: Those fish that have survived all fisheries and will make up a spawning population.

Estuarine: A partly enclosed coastal body of water that has free connection to open sea, and within which seawater is measurably diluted by fresh river water.

Eutrophic: Water body rich in dissolved nutrients, photosynthetically productive, and often deficient in oxygen during warm periods. Compare *oligotrophic.*

Evolutionary Significant Unit (ESU): A definition of a species used by National Marine Fisheries Service (NMFS) in administering the Endangered Species Act. An ESU is a population (or group of populations) that is reproductively isolated from other conspecific population units, and (2) represents an important component in the evolutionary legacy of the species.

Extirpation: The elimination of a species from a particular local area.

Flood: An abrupt increase in water discharge; typically flows that overtop streambanks.

Floodplain: Lowland areas that are periodically inundated by the lateral overflow of streams or rivers.

Flow regime: Characteristics of stream discharge over time. Natural flow regime is the regime that occurred historically.

Fluvial: Pertaining to streams or rivers; also, organisms that migrate between main rivers and tributaries. Compare *adfluvia*l.

Gabion: Wire basket filled with stones, used to stabilize streambanks, control erosion, and divert stream flow.

Genetic Diversity Unit (GDU) is defined as: A group of genetically similar stocks that is genetically distinct from other such groups. The stocks typically exhibit similar life histories and occupy ecologically, geographically, and geologically similar habitats. A GDU may consist of a single stock.

Geomorphology: Study of the form and origins of surface features of the Earth.

Glides: Stream habitat having a slow, relatively shallow run of water with little or no surface turbulence.

Healthy Stock: A stock of fish experiencing production levels consistent with its available habitat and within the natural variations in survival for the stock.

Hydrograph: Chart of water levels over time.

Hydrology: Study of the properties, distribution, and effects of water on the Earth's surface, subsurface, and atmosphere.

Instream Flow Incremental Methodology: Flow modeling methodology used to determine incremental gains in fish habitat, for individual species, at different flow levels.

Intermittent stream: Stream that has interrupted flow or does not flow continuously. Compare *perennial strea*m.

Interspecific interactions: Interactions between different species.

Intraspecific interactions: Interactions within a species.

Iteroparous fish: Fish (such as steelhead) that are capable of repeat spawning. Spawned-out steelhead returning to the ocean are called "kelts." Compare to *semelparous*.

Kelt: A spawned-out fish (such as steelhead or cutthroat trout) returning to the ocean.

Large Woody Debris (LWD): Large woody material that has fallen to the ground or into a stream. An important part of the structural diversity of streams. Usually refers to pieces at least 20 inches (51 cm) in diameter.

Limiting Factor: Single factor that limits a system or population from reaching its highest potential.

Macroinvertebrates: Invertebrates large enough to be seen with the naked eye (e.g., most aquatic insects, snails, and amphipods).

Mass failure: Movement of aggregates of soil, rock and vegetation down slope in response to gravity.

Native: Occurring naturally in a habitat or region; not introduced by humans.

Non-Point Source Pollution: Polluted runoff from sources that cannot be defined as discrete points, such as areas of timber harvesting, surface mining, agriculture, and livestock grazing.

Parr: Young trout or salmon actively feeding in freshwater; usually refers to young anadromous salmonids before they migrate to the sea. See *smol*t.

Piscivorous: Feeding habitat that includes consumption of fish.

Plunge pool: Basin scoured out by vertically falling water.

Push-up dam: A gravel dam (constructed with a bull dozer or backhoe) in the stream channel to deepen and direct water into irrigation diversion canals.

Rain-on-snow events: The rapid melting of snow as a result of rainfall and warming ambient air temperatures. The combined effect of rainfall and snow melt can cause high overland stream flows resulting in severe hillslope and channel erosion.

Rearing habitat: Areas required for the successful survival to adulthood by young animals.

Recovery: The return of an ecosystem to a defined condition after a disturbance.

Redds: Nests made in gravel (particularly by salmonids); consisting of a depression that is created and then covered.

Resident fish: Fish species that complete their entire life cycle in the same geographic area. All lifestages are found in the same habitat. In contrast, anadromous, adfluvial, and fluvial fish lifestages are found in different habitats.

Residual pool depth: The depth of a pool if it is isolated within a dry streambed. Visualize a pool scoured in the streambed. There is water flowing over the streambed upstream and downstream and filling the pool. Now stop the flow of water. Residual pool depth is the depth of water remaining in the isolated pool after the flow of water is stopped.

Riffle: Stream habitat having a broken or choppy surface (white water), moderate or swift current, and shallow depth.

Riparian: Type of wetland transition zone between aquatic habitats and upland areas. Typically, lush vegetation along a stream or river.

Riprap: Large rocks, broken concrete, or other structure used to stabilize streambanks and other slopes.

Rootwad: Exposed root system of an uprooted or washed-out tree.

SASSI: Salmon and Steelhead Stock Inventory.

SSHIAP: The Salmon and Steelhead Habitat Inventory and Assessment Project directed by the Northwest Indian Fisheries Commission.

Salmonid: Fish of the family salmonidae, including salmon, trout, and char.

Salmon: All species of the genus Oncorhynchus (includes chinook, coho, chum, pink, sockeye, rainbow/steelhead trout, and cutthroat trout).

Sediment: Material carried in suspension by water, which will eventually settle to the bottom.

Semelparous: Fish (such as the five species of Pacific Salmon that occur in Washington) that spawn only once, then die. Compare with *iteroparous*.

Side channel: A portion of an active channel that does not carry the bulk of stream flow. Side channels may carry water only during high flows, but are still considered part of the total active channel.

Sinuosity: Degree to which a stream channel curves or meanders laterally across the land surface.

Slope stability: The degree to which a slope resists the downward pull of gravity.

Smolt: Juvenile salmon migrating seaward; a young anadromous trout, salmon, or char undergoing physiological changes that will allow it to change from life in freshwater to life in the sea.

Stock: Group of fish that is genetically self-sustaining and isolated geographically or temporally during reproduction. Generally, a local population of fish. More specifically, a local population – especially that of salmon, steelhead (rainbow trout), or other anadromous fish – that originate from specific watersheds as juveniles and generally return to their birth stream to spawn as adults.

Stream reach: Section of a stream between two points.

Subbasin: One of the smaller watersheds that combine to form a larger watershed.

Thalweg: Portion of a stream or river with deepest water and greatest flow.

Toe width: A method used to estimate instream flows necessary to provide habitat for salmon and steelhead. It was developed in the 1970s in western Washington by the U.S. Geological Survey (USGS), in cooperation with the Washington Department of Fisheries (WDF) and the Washington Department of Game (WDG). The method is based on statistical regressions of habitat, as measured in pilot studies based on actual fish habitat selection, on stream channel widths measured between the toes of the banks. Toes of the bank in riffle areas are indicated by change in cross-section slope, change in substrate, and sometimes by vegetation change. The toe width (usually an average of multiple measurements) is plugged into formulas for juveniles and spawners of different species of salmon and steelhead.

Watershed: Entire area that contributes both surface and underground water to a particular lake or river.

Watershed rehabilitation: Used primarily to indicate improvement of watershed condition or certain habitats within the watershed. Compare *watershed restoratio*n.

Watershed restoration: Reestablishing the structure and function of an ecosystem, including its natural diversity; a comprehensive, long-term program to return watershed health, riparian ecosystems, and fish habitats to a close approximation of their condition prior to human disturbance.

Watershed-scale approach: Consideration of the entire watershed in a project or plan.

Weir: Device across a stream to divert fish into a trap or to raise the water level or divert its flow. Also a notch or depression in a dam or other water barrier through which the flow of water is measured or regulated.

Wild Stock: A stock that is sustained by natural spawning and rearing in the natural habitat.

APPENDIX B: MAPS

APPENDIX C: REFERENCE DOCUMENTS

DRAFT 9/8/00

RAPID ASSESSMENT PROCEDURE FOR AQUATIC HABITAT, RIPARIAN & STREAMBANKS (RAPFAHRS)

by Frank Reckendorf and Ben Tice

Introduction

Since July 1998 periodic stream assessment work along private land has been ongoing in Walla Walla and Columbia Counties, Washington. This work has been done for the Walla Walla and Columbia County Conservation Districts. These conservation districts want to determine total watershed health and stream corridor condition in their partnerships with the Natural Resources Conservation Service and the Washington Department of Fish and Wildlife to install projects that lead to stream restoration.

Data Collection

The field assessment work along streams is generally a continuous recording of data that includes: (1) reach designation, (2) riparian reach length and rating, (3) large woody debris or overhead cover in percent of pool surface, (4) pool substrate, (5) pool depth, (6) pool quality rating index (PQI), (7) stream bank erosion reach length, height, and rating, (8) stream percent slope, (9) stream d50 and bimodal condition if present, (10) Rosgen Stream Classification (Rosgen, 1996), (11) fencing, (12) stream bank geomorphic surface type (i.e. floodplain, terrace, steep hillside, side slope, etc.), (13) locations of water diversions and returns, (14) potential conceptual treatments, and (15) winter rearing habitat. Periodic measurements or documentation is also done for: (1) water temperature and diurnal variation during assessment, (2) riparian type (trees, brush or grass), (3) Global Positioning (GPS), (4) streambed d100, (5) stream bank stratigraphy, (6) percentage of substrate covered with algae, (7) livestock presence in the river, (8) Montgomery and Buffington Stream Classification (Montgomery and Buffington, 1997), (9) Stages of channel evolution (CEM) according to Schumn, Harvey, and Watson, and (10) sinuosity. Frequently the reach length, specific erosion, or habitat conditions were photographed. In general these photographs were taken in a downstream direction. Reaches were usually evaluated from upstream to downstream with right and left banks determined looking downstream. Whenever possible 1998 aerial photographs with a scale of about one-inch equals 500-ft. (1:6,000) were used for designating the reach breaks. New reaches were established based on changes in riparian vegetation, erosion, large woody debris, stream slope, width, substrate, or stream type. Access to stream reaches was provided by notification to landowners by the two conservation districts. The procedure used both written notification and follow-up phone calls. Denied access only occurred in about 5 to 10% of the reaches. Data was collected during low flow conditions in the late summer and early fall whenever possible. However, do to funding constraints, some of the data had to be collected during winter and spring flow conditions up to water depths of half bankfull condition. Follow-up visits were made to get low flow pool conditions. Measurements were made from the reach photos and from older photos and maps to determine stream sinuosity.

Evaluation

The data was summarized for the districts in spreadsheet format. Graphical presentations and queries were also provided. Pool quality, riparian buffer quality, and erosion severity indexes were developed to provide visual aids to help identify priority areas for treatment and differences in stream reach watershed health. Criteria to establish a pool quality rating for a given pool are shown in Table 1. The Pool Quality Index (PQI) is modified from Idaho, WRI (1993). To form the index, the sum of all pool quality ratings in a reach were subtracted from 10. Therefore, the lowest rating of 0 or lower was considered to have the highest pool quality. A reach pool rating of 10 had no pools. Criteria to establish a riparian quality rating are shown in Table 2. An area with a healthy riparian buffer received a rating of 1. Areas with little or no vegetation received a rating of 10. An erosion severity index was created in a similar fashion and is shown in Table 3. A rating of 0 depicts a reach with no erosion. A rating of 10 depicts a highly eroded reach.

Most potential erosion problems are a result of a combination of factors of the type shown in Table 3. A common condition encountered in the field was modified channels with push-up gravel and cobble side slopes. These were rated 6 or 7 depending on side slopes. It is assumed at bankfull and higher flows that the pushed-up or stacked stream cobble and gravel will slough. This is common for this type of stream material when used as a “sugar dike” (one that essentially melts away in high flows).

Table 1. **Pool Quality Rating Index**

1. Depth		
	<0.5 feet	= 0
	between 0.5 and 1.5 feet	= 1
	>1.5 feet	= 2
2. Substrate		
	gravel (<2.5 inches)	= 0
	cobble (2.5-10 inches)	= 1
	boulder (>10 inches)	= 2
3. Overhead cover		
	<10% of the pool surface	= 0
	10-25% surface area	= 1
	>25% surface area	= 2

4. Submerged cover: large organic debris, small woody debris, and other forms below or on the water surface.

<10% of the pool surface	= 0
10-25% surface area	= 1
>25% surface area	= 2

Table 2. **Riparian Rating Index**

Needs Trees Needs enhancement Good

10 9 8 7 6 5 4 3 2 1

-Farmed to edge -Sparse buffer -Narrow buffer with -Trees in buffer -Many lrg. tr.

-Overgrazed -weedy minimal older trees -some shade -good shade

-No strm. shade -livestock dmg. that provide shade -No livestock -veg. healthy

-human disturb.

Table 3. **Erosion Rating Index**

The number of items present that are listed below the rating are used to establish the rating.

10 (3 or more) 9 (at least 2) 8 (at least 1)
Unvegetated, with high stream bank overhang angle.
Unvegetated with high uncemented sandy stream bank.
Unvegetated with a stratigraphy of fines and sands over uncemented gravels and cobbles that occur within bankfull flow condition.
Unvegetated with uncemented gravels and cobbles that occur within bankfull flow condition.
High depth (> 3 ft.) of washed root zone.

7 (3 or more) 6 (at least 2) 5 (at least1)
Unvegetated with moderate stream bank height (1/3 of stream banks still above bankfull) with vertical to 1:1 sloped stream banks.
Unvegetated moderate height of stream bank with uncemented sands.
Unvegetated stratigraphy of fine sand over uncemented gravel or cobble, and contact is above bankfull depth (i. e. terrace).
Low percentage (<25%) of stream bank with roots.
Uncemented pushed-up gravels and cobbles against stream bank or as a “sugar dike”.
Moderate depth (2ft. to 3ft.) of washed root zone.
Cultural evidence of erosion such as stream undercut fences, pipes, buildings, and roads.

4 (4 or more) 3 (at least 3) 2 (at least 2) 1 (at least 1) 0 (no items).
Low (1ft. to 2ft.) of washed root zone.
Low percentage (<25%) of stream bank with roots.

Evidence of recent stream bank sloughing.
Unvegetated stream bank with vertical to flatter slope, unless bedrock.
Unvegetated, uncompacted (i.e. loose) sands.
Unvegetated, uncompacted gravels or cobbles.
Unvegetated, uncompacted stratigraphy of fines over sands or gravel.

Unerosive, very stable stream banks, such as those along bedrock or ones with a good cover of grasses, shrubs, or trees, or those with a high percentage (>50%) of stream bank with roots would rate a zero. In addition stream banks with compacted fines, sands, or gravels that eroded at slow rates were rated between 1 and 3 depending on location (i.e. outside curve position rated higher). Previously treated areas with tree revetments (TrR) or rootwads and boulders (R&B) frequently still showed some low rate of erosion so they may have been rated to show erosion. The reason for this was that there may not have been any associated soil bioengineering treatment, or the treatment was not successful.

A list of potential conceptual treatments used in the assessment is shown in Table 4. The terms Vanes and Barbs are shown to be used interchangeably. However vanes are typically built with uniform rock; barbs are typically built with graded rock sizes.

In general no rock or rootwad treatment was shown for erosion rates of 4 or less. In these reaches only soil bioengineering treatment such as staking were recommended. The exception was when channel reconstruction (CR) or rock weirs (RW) are shown to narrow the channel width and to deepen the thalweg.

All rock structures such as rock weirs (RW) and vanes (V) should be assumed to be installed in Walla Walla and Columbia counties with associated rootwads unless there are special circumstances like a bridge constriction that would preclude their desirability. In addition, unless there are special circumstances, all structures are assumed to be installed with associated soil bioengineering treatment to restore the riparian area, as well as fencing and grazing management.

The final determination of conceptual treatment should be based on a follow-up field visit, discussion with the landowner, and NRCS Standards. The follow-up field visit will place the conceptual treatments into the specific context of bankfull depth, width, and slope. In addition the field visit will establish the associated treatments that may be located across the river or in another reach. For example, a winter rearing channel in one reach may need to be tied in with several R&B (rootwad and boulders) at an upstream location to keep flood flows and sediment from entering the winter rearing channels at the upstream end. A field visit is also essential to determine if there is sufficient channel width or the right stream bank height to install TrR (tree revetment of rootwads with boles into stream bank), verses R&B (rootwad and boulders parallel to stream bank) or OPL (overlapping, parallel logs with rootwads).

Table 4 **Conceptual Treatments**

Treatment	Abv.	Gen. Site Condition & Special Treatment
Staking	S	Floodplain (F. P.) & low terrace (T) scarps and top.
Staking and Geotextile	S&G	Same except add geotextile when gravel side slope.
Dormant Post Planting	DPP	Low and high F. P. and low T scarp and top.
Whole Plant Transplant	WPT	In areas behind TrR, R&B, OPL, J, V, & Other.
Joint Planting	JP	In existing riprap.
Facine	F	Above bankfull condit. on F. P. and T. scarps.
Facine & Geotextile	F&G	Same except add geotext. for gravel, cobble scarp.
Fence	Fn.	Along all stream banks with stock access.
Vegetated Geogrid	VG	Shaped F. P. and T. slopes and repairs.
Live Cribwall	LC	Base of F. P. and low terrace side slopes.
Tree Revetment	TrR	Base of F. P. or T side slopes (boles into bank).
Rootwad and Bldrs.	R&B	Base of F. P. or terrace scarps (parallel bank).
Table 4 (Cont.)		
Overlap. Prl. Logs	OPL	Base of F. P. or terrace scarps slopes.
Instream R&B	IRB	Within channel rootwads and boulders primarily in C's, but also in B's and F's stream types.
Bank Shaping and Vegetation	BS& V	F. P. and some terrace side slopes, especially low terrace scarps.
Rootwad Vanes/Barbs	RV	Rootwad installed as a vane at base of slope.
Vane/Barb	V	Rock vanes should be installed rather than barbs (up to bankfull and pointed upstream).
J Vanes (curved tip)	J	Base of F. P. and T. especially with stable far bank.
Vanes/Barbs With Rootwads	VR	Vanes/barbs with rootwads in pool.
Channel Reconstruction	CR	Blown out C, E., and D Stream Types.
Log Cover Structure	LCS	F. P and T. damaged and reshaped slopes.
Lunker Structures	LS	Base of F. P. or T for fish hab., and bank protect.
Rock Vortex Weirs	RVW	Across channel for aquatic hab. and to narrow.
Rock Vortex Weirs (with Rootwads)	RVW /R	Same with instream rootwads for aquatic habitat.
Rock Weirs	RW	Across channel to narrow, create pools for fish

		passage and to direct flow direction.
Rock Weirs and R	RWR	Same & inchannel rootwad, to create habitat
W Rock Weir	WRW	To direct flow into two channels.
Toe Rock	TR	Base of F. P. or T.
Blders. & Clust.	B &	In some B 2,3, & 4; F 2,3, & 4; and C 2,3, & 4
	BC	To create pools.
Boulder Clusters	BC	Same
Single or Double Wing	SW/	Base of F. P. or T slope.
Deflectors	DW	
Cabled Cross Logs	CCL	Cabled logs to streambed to trap sediment.
Saw-toothed Gabon	STG	Bank protection and edge complexity.

Field Application of RAPFAHRS

This version of RAPFAHRS has been used for field assessment on about 90 miles of channel or 180 miles of stream banks in the Walla Walla River Basin in Washington. An analysis of factors limiting the abundance and distribution of salmonids within the basin is underway. This stream assessment data has been very beneficial to the limiting factors analysis. The amount of large woody debris, pool frequency, and pool quality have been shown to generally be poor throughout the basin. Stream bank stability (erosion) and riparian zone quality are generally fair, however, there are many miles of stream corridors that are overgrazed or farmed very close to the stream bank.

Some obvious problems with procedure measurements have been noted. For example, reach and erosion lengths may be underestimated because distance is measured with a Laser Distance Measurer, which may not always get an accurate measurement of distance around the stream curves. In addition, narrow stream widths (<51 ft.) are sometimes estimated because the lower limit for the laser is 17 yards. (i.e. 51 ft.). However, widths under 20 ft. were usually measured with an extended survey rod. Bankfull depth was determined with a survey rod. Adequate pool length, width, and depth can only be determined at low flow so a follow up visit is needed at selected sites to correct preliminary estimates. Temperature measurements only reflect the narrow time widow that the assessment team was in the river. The d50 and d100 particle size was occasionally measured with a tape, but data for most of the reaches are based on visual estimates because of the size consistency of particle sizes along most streams. In addition the difference between, for example, C3 and C4 is not relevant for most of the potential conceptual treatments. However, there are some stream reaches in the basin that appear to reflect a bimodal distribution of the gravel and cobble sizes. The coarser sizes in these areas were selectively measured.

The speed for doing the assessment varies by stream type, access, extent of fencing, amount of LWD in the river and on the stream banks, thickness of riparian vegetation, the number of times the stream is crossed, water depth, and landowner interest in discussion. Some of the LWD, water depth, and riparian vegetation delays are minimized by doing the work in chest waders so the stream can be crossed to avoid difficult areas. For the overall inventory, the slowest inventory was about 0.75 mile in a day and the fastest about 3.75 miles per day. The average was about 2 miles per day by the two-person team. The data is presently being analyzed for trends of the quality of aquatic and riparian area and stream bank erosion needs.

Conceptual Drawings and Installation

Some conceptual drawings have been prepared after consultation with landowners. These are for treatments that benefit aquatic habitat and reduce land loss due to stream bank erosion. This results in a win-win situation for aquatic habitat and landowners. Conceptual drawings have so far been prepared for about 46 locations, most of which are along Coppei Cr. in Walla Walla Co., which was inventoried using a different procedure. Aquatic habitat and related stream bank protection work was installed on about a dozen site reaches in the late fall of 1998 along Coppei Cr. Redd surveys along Coppei Cr., in the spring of 1999, have found 47 steelhead redds around the project work.

Assessment Use

The assessment reflects that there are many miles of riparian area that need vegetative treatment and fencing in the Walla Walla Basin. The Walla Walla Conservation District and Columbia Conservation District have already installed several miles of soil bioengineering treatment and fencing. The re-establishment of riparian corridors in the Walla Walla Basin will help to re-establish connectivity of the wildlife habitat.

The assessment is also being used to discuss with the landowners the various aquatic habitat, riparian area, and stream bank erosion problems that may exist along their specific stream reaches. The landowners decide if they want to participate in the restoration work. The districts, in consultation with their partners the Natural Resources Conservation Service (NRCS) and the Washington Department of Fish and Wildlife (WDFW), decide which projects have priority for conceptual design, analysis, permit, and treatment. The assessment provides some of the range of treatment strategies for a given reach. Not all treatments are applicable for every site and depend to a large degree on stream type and stream width considerations. At the conceptual treatment stage of project work, the range of treatments in the assessment may be expanded or reduced based on landowner, NRCS, or WDFW interest. Species listed as threatened under the Endangered Species Act are found within much of the Walla Walla Basin. Biological assessments are often needed prior to granting of permits. Both the stream assessment and conceptual drawings are being used as part of the biological assessment process. The stream assessment also gives a perspective of the watershed health of the various sub-watersheds, as well as the whole Walla Walla Basin.

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